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A Message From President FitzGerald

THE American Congress on Surveying and Mapping came into being on the eve of a national emergency and served the surveying and mapping professions with distinction during one of the most critical periods in the life of the Nation. In a few short years we have made steady and, at times, spectacular progress in promoting the original objectives of the Congress. Our Tenth Anniversary Meeting was an impressive tribute to the working membership of the organization who certainly believe the effort has been worth while. The President, the Board of Directors, and other officials of the American Congress on Surveying and Mapping, elected or appointed to carry on the business of the organization, are fully occupied in professional or technical work and they serve the Congress entirely on a volunteer basis. How well they have performed this job during the past 10 years is amply demonstrated, I believe, by the growth and composition of the Congress today. Organized by a small group of our contemporaries, the Congress is now well established and recognized as an international society of some importance. Accredited representatives have attended surveying and mapping meetings during the year in many parts of the world. In the United States, local groups or sections are being organized to spread the gospel and strengthen the organizational structure. This is progress measured by any yardstick.

The possibility of a new emergency, or even war, can no longer be discounted. Already we are feeling the impact of a great defense program on surveying and mapping activities; there is a gradual shift from peacetime plans and programs to defense projects. The military organizations responsible for this work are increasing their plant capacity and personnel as rapidly as conditions permit. It is safe to predict that unless there is a decided change in this already well-established trend, the military services alone will double their existing capacity for the production of military maps and charts within the year.

The future holds promise of the establishment of a new and important milestone in the history of mapping and charting in this country. Legislation introduced in the House of Representatives during the last session would provide for comprehensive mapping and charting programs covering geodetic surveying, topographic mapping, hydrographic surveying, cadastral surveys, and geologic mapping. This Bill, H.R. 6900, after extensive hearings before the Public Lands Committee of the House, received unanimous approval of that group and there is reason to believe that it will be introduced again at the 82nd Congress. Every member of the American Congress on Surveying and Mapping has an interest in this legislation. Those of us here in the United States are directly interested because of the effect it will have on the existing mapping and charting programs. Members from other countries will find in the support for this bill an added incentive to work for the adoption of their own mapping and charting programs.

There is every indication that 1951 will be a busy and important year for the American Congress on Surveying and Mapping. This means greatly increased responsibilities not only for the officers of the Congress but for the entire membership. It will take a lot of willing hands to keep the wheels turning, and I'm going to call on many members during the coming year to take some of the work load that must be shared and should be shared if we are to continue to advance the sciences of surveying and mapping in their several branches.

GERALD FITZGERALD
President

The Relationship of Mapping and Charting to the Defense and Development of the Americas

By LT. GEN. WILLIS D. CRITTENBERGER

CHAIRMAN, INTER-AMERICAN DEFENSE BOARD

IT IS CERTAINLY GRATIFYING to appear before this group and talk about something which is so basic and vital to the various international programs with which I am associated. I refer to mapping and charting, which I may allude to collectively at times as cartography.

Here in this Congress there exists an understandable appreciation of the vital significance of maps and charts in virtually all walks of life. Regrettably, the vital significance and economy of providing good maps and charts are not so universally recognized in other circles. Like many small and little-known, but vital, components of larger activities and programs, cartography is sometimes overlooked and not appreciated. Even more regrettable, due to this lack of appreciation plus a lack of training in the uses and values of maps and charts, is the fact that many potential users do not always know what they are missing.

CARTOGRAPHY IN MILITARY INTELLIGENCE

It has been estimated that in the military field a good topographic map provides about 30 or 40 percent of the military intelligence required to operate successfully in an area. The military map speaks volumes of narratives on one sheet of paper. It is of primary importance, also, in strategic intelligence and planning. It is the finest one-sheet intelligence document in the world. It can tell even more than a good photograph or an aircraft observer overhead.

There is no better way for a group of individuals to get a common mental picture of an area or situaion than from a map. If it read volumes of narratives describing the area or situation this group of individuals would not arrive at the same common mental image as it would by glancing at the map sheet. To make this point clear: Would you like to find your way about the Washington, D. C., area from a 10-volume, cross-referenced narrative treatise on the area instead of a 1-sheet town plan or the excellent U. S. Geological Survey topographic and street map of the city and its environs?

A map is also an operational instrument, which should accompany virtually every weapon, whether it be a machine gun, heavy artillery, or a long-range bomber. Without the accompanying map, these other tools of war, costing thousands of times as much as the map itself, are rendered largely ineffectual. There is hardly any one component of the modern fighting team which can contribute more for less to its efficiency and effectiveness than good, accurate maps coupled with an ability to use them properly.

PRESENT MAP COVERAGE DEFICIENT

Is it not amazing that less than 2 percent of the earth's land is adequately mapped to a scale large enough to enable intelligent and efficient development

Presented at Tenth Anniversary Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 21–23, 1950.

and planning and that less than 25 percent of the land is covered by even good reconnaissance maps of a medium scale? And is it not even more surprising to note that in our own United States less than 20 percent of its area is covered by good large-scale maps?

It would be interesting to attempt to calculate how much this lack of mapping and charting is actually costing the Government of the United States and the governments of the world in decreased efficiency and economy in the many undertakings currently in progress. I believe this deficiency is significant when we realize that there are well over 25 non-military international organizations concerned with mapping and charting or dependent very directly on the use of maps and charts.

INTERNATIONAL INTEREST

As an example of the interest of an international organization in mapping, the United Nations on several recent occasions, especially in two Economic and Social Council resolutions, has recognized the necessity of maps and charts for the proper development of world resources, for facilitation of international trade, for safer navigation, for provision of information for the peaceful adjustment of international disputes, and for the application of international security measures.

To this end, the establishment of a Cartographic Office within the United Nations has been recommended. The services of this office would be available to coordinate the international mapping interests and activities of all member nations in order to stimulate greater activity, to standardize techniques, and to eliminate duplication and conflicting efforts.

In addition to this operating and coordinating office, supported by an international panel of consultants, it is especially noteworthy that it was also proposed to foster regional meetings among groups of neighboring nations which are related either geographically or economically for the purpose of stimulating uniform and international mapping and charting programs throughout these given geographical areas. As is true of many other activities, mapping, to be pursued economically and well, finds itself handicapped if restricted by political boundaries and barriers, although progress is made each day in crossing international boundaries to the advantage of all.

Such a step may indeed be hailed as a significant one in the interests of world unity and peace as well as in the advancement of the joint interests of mankind the world over.

LATIN AMERICAN COOPERATION

The first series of regional meetings of the type proposed by the United Nations were held in Latin America under the auspices of the Pan American Institute of Geography and History. The first organization actually to take action of this nature was the Inter-American Geodetic Survey, which was organized within my Caribbean Command several years ago. At that time—just after the War—I was directed by the Department of the Army to set up a mapping and charting program throughout Latin America which would, in effect, implement with an action program the aims stated so ably and for so long a time by the Commission on Cartography of the Pan American Institute of Geography and History. The readiness with which the many Latin American governments accepted this program in spite of their many political differences and the success

which this program has attained in its four short years of operation testify forcibly to the wisdom and soundness of such an undertaking.

Some of the details of this program were related to the American Congress on Surveying and Mapping last year by Col. F. S. Tandy, whom I designated as Director of the Inter-American Geodetic Survey, and earlier in this year's meeting by W. G. Stoneman, also of the IAGS. It is to be emphasized that the major part of this program is being executed by the nationals of the various collaborating Latin American nations involved, with the United States providing only the international and technical coordination and assistance in the way of instructors, technical consultants, and loans of critical equipment as required.

Even as a forerunner, this program was directly in line with the objectives of the Rio and Bogotá Conferences and the Organization of American States. It certainly will provide valuable planning data and blueprints which will make any developments envisaged more efficient, economical, and expeditious.

OTHER COOPERATION IN THE WESTERN HEMISPHERE

As proud as we are of the commendable strides made in the Latin American cartographic program, it should not overshadow the fine work which is going on elsewhere in the Americas and, indeed, throughout the world.

In Alaska, the U. S. Geological Survey, the U. S. Coast and Geodetic Survey, the Army, Air Force, and Navy are effectively collaborating in mapping areas from the frozen reaches of tundra in the north to the fertile and temperate valleys of the south, all of which have great significance to the economic and military future of the United States and the Western Hemisphere.

It is also gratifying to emphasize the close and effective collaboration between the United States and Canada in mapping and charting, both technically and area-wise. As a significant block of the over-all picture of mapping in the Americas, the Canadians have a very active program, which is progressing well. Canada is making great progress not only area-wise but in adopting new techniques and procedures. Their progress in putting Shoran to work in both geodetic measurements and Shoran-controlled photography is especially commendable and accounts for some of their strides in mapping.

OTHER INTERNATIONAL COOPERATION

It is significant in the international mapping picture that the United States has been actively engaged in advancing the state of mapping in various previously unmapped or poorly mapped areas in the Pacific as well as collaborating closely in improving the geodetic data in Europe. Under the well-known Economic Cooperation Administration there has been opportunity to advance aerial photography and mapping, through our friends the British, in some of the outlying areas in Africa which may well figure strongly in the future economic interrelationships of world trade in those areas.

The part which the Coast and Geodetic Survey is playing through the Inter-Departmental Committee on Scientific and Cultural Cooperation enters very significantly into this international mapping scene. Students from nations throughout the world are brought to Washington, D. C., by this Inter-Departmental Committee to study modern techniques and equipment. Such interchanges of technical ideas are significant to efforts for standardization of techniques and equipments throughout the world, which facilitates the exchange of information or ideas in the interests of commerce.

MAPS AND CHARTS FOR DEFENSE

I have emphasized the sincere hope that the future applications of mapping and charting will be in peacetime economic and industrial pursuits and that their military character will not overshadow their value to a civilian economy. The multiplicity of types and uses of maps in the many walks of civilian life, however, are paralleled, if not exceeded, by the many special demands in the event of armed conflict.

Electronic navigation, strategic bombing, amphibious operations, anti-submarine warfare; and the use of radar, radio-ranging devices, and supersonic aircraft inject complex requirements for maps and charts that scarcely a decade ago would have been considered of a "Buck Rogers" character. Beyond this, these new requirements carry with them the increased need for better and faster methods, equipment, and techniques for map making.

Maps and charts which are to be used in military operations must be prepared for the most part beforehand. At least the source material must be accumulated, integrated, and well cross-referenced for ready compilation and printing when the need arises.

To illustrate this point, it has been estimated that for the Armed Forces of the United States to thoroughly map at a large scale an overseas area 150 by 300 miles would take 5 years under the present peacetime tempo of operations. Furthermore, it is estimated that it would take almost 2 years under an emergency program with a concentrated effort. This is under the dubious assumption that we might have access to the area.

I wish to emphasize that the field of map and chart production is one in which active and intensive military preparation is directly and fully usable by the civil economy. The same surveying, the same aerial photography, the same research studies, and the same finished maps and charts, which are such urgent requirements for military uses, are of equal application and value to the peacetime pursuits. The military map and chart makers may take pride in the fact that they are making substantial and vital contributions to the peacetime economy and development of their respective nations.

One of the most vital international undertakings is that of relating one mapping datum to another, or the integration of several datums into one over-all datum covering a large related area. The ultimate is, of course, a single datum for the entire world. Mapping and charting in their inception were probably the most unrelated of activities ever undertaken—a hodge-podge of map series and geodetic datums growing around isolated areas where mapping and charting were first started. When such units of mapping expand to where they overlap with one another, the resulting coordination that is necessary presents serious difficulties, as many of you can testify who were confronted with the separate datums throughout Europe and North Africa during this last war.

In conclusion, may I say that there is no doubt from every point of view as to the value of the work which your Congress is carrying on. Its value to the United States, to all the Americas—indeed to the world at large—cannot be estimated in dollars and cents.

Education for the Land Surveyor

By G. BROOKS EARNEST

PROFESSOR OF ENGINEERING SURVEYING, CASE INSTITUTE OF TECHNOLOGY, CLEVELAND, OHIO

IT IS a genuine pleasure to appear on the program of the Tenth Anniversary meeting of the American Congress on Surveying and Mapping. As a charter member of the Congress I enjoyed the honor of presenting a paper entitled "City Surveys" at the initial meeting back in 1941. The Congress has made rapid strides in progress since that first meeting, and I hereby congratulate you men present who have provided the initiative, who have figuratively carried the ball, and who are responsible for the splendid development of this society. I know that personal time and money has been spent by your leaders in piloting the Congress to the position it holds among national societies today.

When approached by Mr. Wattles (through correspondence) to prepare a paper on "Education for the Land Surveyor" I registered reluctance on the basis of inadequate qualifications. He implored that I choose my own subject but touch upon the educational aspects or lack of same concerning the subject of "Land Surveying" as reflected in modern college curricula. A better title for this paper would be "Education—As Relates to the Student in Civil Engineering."

I could undoubtedly make three or four brief statements relative to the magnitude and character of the respect paid to surveying and mapping courses in a number of our engineering colleges today—throw this meeting open to discussion, and have a more interesting session, but then I would be derelict in the responsibility accepted for Mr. Wattles. Please be assured, however, that during 21 years in the teaching profession I have heard many alumni expound their theories relative to that which they think should be taught in our engineering colleges today.

Suppose we attack the problem (if it may be called a problem) from several angles, considering the major premises of (1) "importance of subject," (2) "time," (3) "quantity of material in present curriculum," and (4) "quality of instruction."

JUST HOW IMPORTANT IS LAND SURVEYING EDUCATION?

Just how important is it that considerable stress should be laid on the subject of "Land Surveying"? How many Civil Engineering graduates have entered and remained in this field in the past two or three decades? I don't have facts and figures for other colleges, but since 1920 Case Institute of Technology has graduated a total of 547 Civil Engineering students or an average of 18 per year. Of this number I have knowledge of only two who are presently engaged in land surveying and, in addition, two non-graduates who are engaged in the profession. There are undoubtedly others, but the percentage of the total is very small. The number of graduates engaged in the field may not be classified as a yardstick of the importance of the subject; however, heads of civil engineering departments surely use such data as a criterion of the importance of such training as compared with other components of the curriculum. The control of courses offered

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and course content rests pretty much with the heads of the civil engineering departments.

THE TIME ELEMENT

Now let us look at the "time" element. Most engineering colleges have expanded their humanities courses in the past decade. This was usually accomplished at the expense of hours in class and laboratory in technical subjects. The engineering graduate of today must be a cultured gentleman, endowed with the ability to write business letters, appear on a rostrum with eloquence and grace, and when need arises, with dinner jacket. There are many who think that many of these niceties can be acquired subsequent to graduation rather than at the expense of fundamental engineering knowledge. This is a controversial subject even among faculty members.

The need for maintaining class and laboratory hours in the basic sciences and engineering subjects while still conforming with present day demands for the humanities has been met in two ways: (1) by adopting the 5-year plan and (2) by creating the "Binary Curriculum" between liberal arts colleges and engineering colleges as recently announced by Case Institute of Technology. The latter plan involves 3 years of study at a chosen liberal arts college and 2 years and a summer of work at Case. Upon completion of the graduation requirements of each institution, the student will receive the B.A. degree from the liberal arts college and the B.S. degree in his specialized engineering field from Case. Five middle western colleges have combined with Case for this "Binary Curriculum," namely, Coe College, Cedar Rapids, Iowa; De Pauw University, Greencastle, Ind.; Oberlin College, Oberlin, Ohio; Ohio Wesleyan University, Delaware, Ohio; and Marietta College, Marietta, Ohio.

EVOLUTION OF ENGINEERING CURRICULA

Another element of time, as well as quantity of material covered, arises from the natural evolution of civil engineering subjects during the past quarter century. We really don't have to go back that far to pick up names of comparatively new courses. Just to mention a few: soil mechanics, photogrammetry, fluid mechanics, airport engineering, city planning, and hyperstatic structures have only recently been added. Then too, much development has taken place within those courses which have been in existence for a long time. The introduction of the Hardy Cross method of moment distribution, which analogy is also adaptable to the distribution of the flow of water in a network of pipes; new developments in the manufacture of cement and in industrial trade waste treatment; and new methods for the design of highway and airport runway slabs are just a few of the items brought about by research which have added to the thickness of present day textbooks.

Because of new courses added to the civil engineering curriculum and additional material accumulated in existing courses, some course material had to suffer. The surveying and mapping courses were decimated as much as, if not more than, any other branch of civil engineering in order to meet modern demands.

Regarding quantity of material covered in the surveying courses, the question is raised as to whether many aspects of surveying should be given the "once over lightly" or should a few of the more important aspects be stressed in detail.

Furthermore, the distribution of class versus laboratory time may be a critical factor affecting quantity relative to theory versus practical application. The surveying camp or summer session policy, adopted by many engineering colleges, affords a splendid opportunity to not only increase the quantity of material over and above the semester course content, but also to serve the humanities departments by throwing the entire class together in the open, working, playing, and living together as a group. The practical aspects of surveying learned in camp may almost be considered secondary to gaining the knack of getting along with one's fellow students.

Introspection of the factors presented thus far makes it appear that a block is being thrown into the subject of "Education for the Land Surveyor"; however it is not the author's objective to depreciate the subject, but merely to recite several factors which influence the scope and purpose of the components of the present day engineering curriculum. There are at present fewer clock hours of class and laboratory scheduled weekly than there were a decade or more ago, and the student (the product with which we work) has not become correspondingly more brilliant that he can assimilate a greater bulk of material in a shorter period of instruction.

Professor Russell C. Brinker, University of Southern California, edited the results of a questionnaire in the February 1949 issue of the *Civil Engineering Bulletin* of the American Society of Engineering Education. He showed that the average surveying and mapping credits required in 153 engineering colleges was 11.4 with a high of 25 at Cincinnati University, and a low of one at Brown University. There were only two other colleges with credit requirements less than six, namely, Harvard with three, and Rhode Island State College with four. At the time of the report, Case was above the average with 18 credit hours.

If one would make a study of the same 153 engineering colleges respective to curriculum in structures, hydraulics, sanitation, transportation, or construction there would undoubtedly be a wide variance in credit requirements. No two colleges are identical in their credit requirements—thank goodness. Since there are these variances, what conclusion can one draw concerning course content?

To begin with, essentially all education is planned to acquaint the student with the basic material and to help him become proficient in his chosen field. Considering the problem with respect to the field of surveying—what are the prime purposes of the various courses in surveying and mapping in a civil engineering curriculum—or perhaps the question could be phrased better by asking what should the professor in surveying strive to cover in his allotted time?

FUNDAMENTAL INSTRUCTION

Fundamentally, the instruction in the proper care and use of all types of surveying equipment is prerequisite to all branches of surveying. The student should be indoctrinated with the relative values of all types of equipment, and the limitations of its use. Principles of economy in operation are of utmost importance, for the civil engineer or surveyor must be able to plan as well as execute surveys which will expedite the project to successful conclusion, and make a profit for him or his employer.

Accordingly, considerable stress should be laid on the ordinary simple surveying problems in order that certain do's and don't's are photographed on the

student's mind. Repetition has always been and always will be one of the best tools used in the teaching profession. Once the student is acquainted with proper elementary usages he is better fitted to assimilate usages in the special branches of surveying. *One important requirement for this very basic beginning is that the instructor be qualified to teach the subject and likewise have a special interest therein.* This is one of the most important points made in this paper. Too often the assignment for the surveying instruction is made to instructors primarily interested in another branch of civil engineering or engineering mechanics, or even to graduate assistants who likewise usually have special interests other than surveying.

SUGGESTED DISTRIBUTION OF TIME

Since, as noted earlier, the average surveying and mapping college credit requirements approximate 12, perhaps a natural distribution would be as follows:

(1)	Elements of Surveying	4 credits
(2)	Route Surveys	3 "
(3)	Advanced Surveying	3 "
(4)	Photogrammetry	2 "

The course content is fairly obvious in this projected distribution. Mapping principles would be included in (1), (2), and (4). Mapping by means of aerial negatives or photographs has advanced so rapidly in the past decade that its uses and limitations must be a part of all civil engineering curricula. Where the credit requirements are greater than 12, the added credits should be placed with (1), or (3), or both.

Where does the subject of this paper, "Education for the Land Surveyor," fit into this projected program? A few essentials may be considered in all four courses, but the major portion should fall within (3) which would consist of specialty surveys in addition to first- and second-order control surveys.

No college education places a finished product in the field. A doctor must serve an internship; a designer, planner, teacher and others in the engineering profession, an apprenticeship. So why shouldn't the prospective land surveyor, following a degree in civil engineering which included the basic courses cited heretofore, apprentice himself to a professional land surveyor for an indoctrination into that part of his work which he can only learn by doing?

THE MAIN OBJECTIVE

I have deviated slightly from Mr. Wattles' suggestions concerning presentation of my viewpoints on certain items, both academic and practical. Since colleges vary so greatly in scope of surveying training it would be useless to outline a model curriculum and a recommended course content. The main objective is to graduate an A-1 product, and this is achieved through two principal measures: (1) to have a well qualified product to start with and (2) to provide good teaching. Dean H. P. Hammond, Pennsylvania State College, wrote an article on "Good Teaching" in the April 1950 issue of *The Journal of Engineering Education.* The following is quoted from that article: "Good teaching is the development of the student's ability to do things for himself." Certainly self-reliance is an important trait desired in every employee and the college professor should assume as part of his responsibility the inspiring of self-reliance in his product. This means guiding the student in the ability to do and to create.

In conclusion I should like to emphatically state that engineering college administrative heads should consider it just as much of an obligation to choose qualified staff members who are interested in the field of surveying and mapping as it is to choose experts in the field of structures, sanitary engineering, or any of the other specialty branches of civil engineering. There will always be a need for control surveys, boundary surveys, construction surveys, and surveys of other individual significance. Surveys form one of the most important adjuncts to all engineering projects—every effort should be made to keep the surveying and mapping courses in the engineering colleges in the "professional category," and not let them slip into the sub-professional status as has been the case in many colleges. As one of the oldest branches in the civil engineering profession, surveying should always maintain its stature among its sister branches.

* * *

Air Navigation Aid

An important forward step in flying safety is a contract recently signed in Washington by the U. S. Civil Aeronautics Administration for 450 ground stations equipped with distance-measuring apparatus.

By means of them, a pilot in flight will continuously know his distance from a radio range. The equipment, known as DME for short, will use radar-type radio pulse transmission.

The DME transponders are part of a revolutionary new air-navigation system being installed for civil and non-tactical use under a program developed by the Radio Technical Commission for Aeronautics. It is a companion device for the 400 new omnirange stations, 300 of which are now in use. These provide static-free radio beams in all directions for pilots to follow.

The DME equipment, as explained by CAA, is one of the electronic miracles born during the last war. It is a much-improved and modified version of the radar beacons, known as "racons." It operates on very high frequency in the static-free part of the radio spectrum.

In use, aircraft must be fitted with a special radio transmitter and receiver. The transmitter sends out coded pulses of radio energy. The ground-based DME equipment receives these pulses and then hurls back another set of radio pulses to the plane. The time required for the "round trip" is measured by the receiver in the plane and translated into miles for the pilot.

Each DME ground station can serve 50 aircraft at the same time. With modifications it could serve more. Its normal range is about 40 miles for a plane at 1,000-foot altitude and up to 200 miles at very high altitudes.

Under the contract signed, the first DME transponder will be delivered to the CAA for testing late this year. Others will follow, reaching 40 units per month by June 1951. The contract is with Hazeltine Electronics Corporation, Little Neck, L. I.—*Science News Letter*, July 22, 1950.

Concerning Reliable Survey Measurements

By E. D. MORSE

CIVIL ENGINEER, HOUSTON LIGHTING & POWER COMPANY

ONE of the more perplexing problems encountered in land surveying is the matter of determining the degree of reliableness to place on measured angles and distances. Mathematically, the two types of measurements are, in their effect on the error of closure, interdependent in any traverse, but in the discussion to follow they will be treated separately.

MEASURED ANGLES

A closed transit-traverse affords an angular check which, except for possible canceling errors, gives the surveyor a fairly reliable index to the accuracy of his instrumentation. Since angular errors are usually more easily detected than linear ones, an increasing number of surveyors are improving the quality of their angle work, particularly in the urban areas. This can be done in several different ways, notably by a more careful centering of the instrument and targets, by use of a higher precision transit, by turning all angles in azimuth rather than by deflections, and by accumulating several repetitions of each angle on the limb of the transit and obtaining the mean value. A consistent use of all of these methods entails relatively little additional time for properly trained personnel and insures a low angular closure.

In recorded deed field notes of recently surveyed tracts of valuable land, it is not unusual to find the distances given, even for sides two or three thousand feet long, to the nearest tenth and sometimes hundredth of a foot, yet the bearings are carried only to even minutes. As an angular change of 20″ moves a line a tenth of a foot at a thousand feet, lines of that or greater extent which are shown to tenths or hundredths of a foot should carry bearings to the nearest 10″ to be consistent.

Federal specifications for third-order work require a minimum traverse angular check of 30″ times the square root of the number of angles, and a linear check of 1 : 5,000. For second-order work the minimum requirements are 10″ times the square root of the number of angles and 1 : 10,000 for linear check. Expensive equipment is needed for first-order work and it is beyond the scope of all except high precision control surveys, usually conducted by the U. S. Coast and Geodetic Survey.

MEASURED DISTANCES

While the angular closure of a traverse is relatively simple to obtain, a check on the measured distances ordinarily can be had only through a summing up of the products of the distances with the trigonometric functions of the bearings which are derived from the adjusted angles. The ratio of the closing error to the perimeter of the traverse is commonly taken as the proper index to the precision of the work. Thus, a closed survey with sides totaling 5,000 feet that failed to close by 1.0 foot would have a closing error of 1 : 5,000 and be classed as third-order work. This order of accuracy is generally regarded as adequate for map control work of limited extent, some construction projects, and the majority of rural property surveys. With favorable terrain and no actual mistakes made in the work, it is possible to obtain this degree of precision, at least theoretically,

without the use of any special equipment and by exercising only elementary precautions. Any surveyor with a reputation for careful field work is not likely to be satisfied with a poorer check than that.

It will be noted that the only check on the measured distances, even in a closed traverse, is one obtained in combination with the angles. Even with a satisfactory angular closure, the surveyor cannot know with certainty how the closing error from the trigonometric check should be apportioned between the angles and distances. For a single traverse, the most widely accepted practice is the use of the "compass rule" formula. This calls for the prorating of the total errors in latitude or departure of the traverse into the individual latitudes or departures in direct proportion to the lengths of the corresponding sides. This adjustment generally results in affecting the angles about as much as it does the distances, the theory being that in careful and consistent work, both elements contribute equally to the closure. In a network of interlocking traverses, the problem of adjustment becomes somewhat more complex.

A fact overlooked by a considerable number of surveyors is that consistently low closing errors in traversing does not necessarily mean that true accuracy is being obtained. It simply means that *consistent* work is being done. An appreciable deviation of the tape from the standard length is not brought out in the closing error provided that all of the taping is done under similar conditions and the traverse loops on itself. A much more reliable check on the accuracy of a survey is one obtained by traversing between any two Coast and Geodetic Survey first-order triangulation stations. The minimum precision required there is a position check of 1:25,000 between base lines through an arc of triangulation. Actually, an average of 1:75,000 is ordinarily obtained. To accomplish this, base lines are measured so as to insure a probable error not in excess of 1:1,000,000 and average triangle closures held to 1″.

A first-order base line was established in March 1942, immediately south of Houston. While it is not feasible to measure directly between the two base line stations, a line can be taken conveniently along either the connecting railroad track or the shoulder of the adjoining county road.

Three common sources of tape error frequently neglected in this area are:

1. *The tape is not of standard length even when used under the conditions called for by the manufacturer.* Variations in the order of ± 0.01 foot for a 100-foot tape are not uncommon and occasionally a good deal more than that can be found. Accurate results should not be expected of a tape which is divided so as to place the end divisions at the ends of the thong holders. Such tapes, as well as those with graduations on solder or sleeves, are not accepted for certification by the National Bureau of Standards. Obviously, a tape which has been kinked or inaccurately mended for breaks will not give reliable measurements. It is possible, however, to obtain deceptively good closures with such a tape.

2. *The tension or pull applied to the tape is not the proper amount to obtain the standard length.* The tension specified for tapes of different manufacture may vary somewhat. Most of them call for 10 pounds of tension when the tape is supported horizontally throughout. Ordinarily, chainmen consistently apply considerably more pull to a tape than this, even when on level ground or pavement, to bring the tape into straight alignment and to compensate for uneven support. Taking the modulus of elasticity for the usual 5/16-inch width medium weight steel tape at 28 million pounds per square inch and the cross sectional area

at 0.003 square inch, an increase in the tension by 15 pounds on a 100-foot tape will lengthen it by nearly 0.02 foot. Although it is not as important a factor in the Houston area as in hilly terrain, careful leveling and plumbing of the tape are essential in obtaining accurate measurements. A difference of 2 feet in the elevation of the ends of a 100-foot tape on a uniform slope will introduce an error of 0.02 foot. Either the vertical angle of the slope or the difference in elevation of the tape ends should be recorded unless the tape is held level and the ends plumbed down. A 100-foot tape, which is standard at a given tension when supported horizontally throughout and weighs about 2 pounds, requires an increase in the tension of about 18 pounds to bring it to standard length when supported only at the ends.

3. *The temperature of the tape at the time of use varies from that at which it is designated to be standard.* Survey tapes are intended to have their standard length at 68° F. under specified conditions of support and pull. The coefficient of thermal expansion for ordinary steel tapes is 0.00000645 per 1° F. Thus, a variation of 31° F. from the standard temperature will change a 100-foot tape by 0.02 foot, or about $\frac{1}{4}$ inch. This difference alone amounts to 1.0 foot in 5,000, the maximum amount allowed for third-order work. There is a seasonal range of taping temperatures in the Houston area of at least 100° F., i.e., from 30° F. to 130° F. The latter temperature is frequently reached during hot mid-summer days on asphalt paving and along railroads. A taping temperature variation of 40° F. or more is not unusual during the summer on alternate clear and cloudy days. The land surveyor who regards tape corrections for temperature changes as an unnecessary refinement must have some misgivings at times about the performance of his chainmen. When the boundaries of a projected real estate subdivision are surveyed in one season and the staking out is done in another, from calculations based on the previous survey, an appreciable amount of adjusting and finagling in the field is inevitable. This is particularly true of subdivisions having curved streets where many hours of tedious and involved calculations are required to obtain *consistent* dimensions to 0.01 foot for the approval and recording of the dedication plat.

Most of the land surveyors are aware of the three sources of taping errors described here, but feel that the over-all effect of them on the results does not justify the time and expense of taking them into account, particularly where a good part of the field work must be done over rough terrain. An important factor neglected in this reasoning is that all three of the tape errors described are, unlike minor errors in careful pin setting by competent chainmen, likely to be cumulative in their over-all effect rather than canceling. A surveyor may, by careful transit work and by aligning and plumbing the taping, obtain a trigonometric check from his traverse closure which indicates an error of only 1 : 10,000. Assuming that the tape is too long by 0.01 foot under standard conditions, that extra pull extends it by another 0.02 foot, and that temperature lengthens it by an additional 0.02 foot, the cumulative error in the taping alone is 1 : 2,000. In order to compensate for the first two conditions, the taping temperature would need to be down to 22° F., a highly unusual circumstance in this area.

EXPERIMENTS IN HOUSTON, TEXAS

In the business district of Houston, practically all of the property and building surveys are keyed to the city reference monuments, often in conformance with

long-established building line ordinances. These reference monuments were originally set at about two-block intervals, but repaving and underground utility construction have reduced the total number by possibly 50 percent. It is still possible to line up and project combinations of the remaining monuments so as to obtain intersection points within one or two blocks of a needed location. It is customary, however, to support each new survey with a measured tie to at least one existing monument, even if it is three or four blocks distant. Surveys of such valuable property are intended and represented to be made with "tack point" accuracy and heated disputes over conflicts in the order of 0.1 foot are not unusual. The relation of such a conflict to the reference monuments may not be the principal point at issue, but the chances are that both parties to such a dispute have used uncorrected tape measurements and that the true distances may well differ substantially from that claimed by either of them.

Some 18 years ago, the Engineering Department of the Houston Lighting & Power Company was experiencing considerable difficulty in obtaining satisfactory traverse closures for coordinated mapping in the City of Houston. The field work was done piecemeal in spare time with ordinary equipment and during whatever season the personnel was available. Only a few seasons were required to demonstrate convincingly that uncorrected temperature differences alone could increase the probable error of the coordinates to an alarming extent. An early graphic illustration of this point was obtained in downtown Houston. A line along a three-block portion of a paved street between two city reference monuments was remeasured on a summer morning because the previous measurement, which had been made during the preceding early spring, would not conform with the current work. When the first measurement was made, tacks had been driven in the paving to mark the tape lengths. On the later measurement, the same tape and the same chainmen were used and the tacks were still in the pavement. However, the temperature had evidently increased by some 45° F., because an accumulative increase of about 0.03 foot in each 100-foot tape length was obtained, amounting to 0.3 foot for the three blocks.

Selection of Tapes

Later, it was found that even with standardized taping equipment and a higher order of angle work no satisfactory adjustment of a growing network of traverses could be obtained for a large area without recourse to a system of fairly high precision triangulation for over-all control. In order to establish adequate base lines for this project, a suitable 100-foot steel tape and a K. & E. Lo-var (registered trade mark) 100-foot tape were purchased and sent to the National Bureau of Standards for certification of the required pull for each under various conditions of support.

The Coast and Geodetic Survey utilizes the 50-meter Invar tape for base line measurements. The alloyed metal of this tape has a very low coefficient of expansion—some tapes have even been found to have a negative coefficient—but the metal is soft enough to be easily kinked and the alloy is sufficiently unstable to require rather frequent re-standardizing for high precision work. The coefficient of thermal expansion check at the National Bureau of Standards is somewhat costly by reason of having to change the temperature of a large laboratory over a wide range under control conditions.

The Lo-var tape, while not possessing as low a coefficient rating as Invar, has

the advantage that goes with a more stable alloy and the coefficient of the one obtained by Houston Lighting & Power Company was 0.00000083 F., or only about one-eighth that of ordinary steel (Keuffel & Esser now advise that Lo-var tapes of the most recent manufacture have a coefficient of 0.00000022 per 1° F.). In common with other base-line tapes, it carries a graduation mark only at the ends and at the mid-point, requires special handling when in use, and must be stored on a large diameter reel. A standardized steel tape is required for odd end measurements.

For Houston Lighting & Power Company's Engineering Department traversing of second-order or less precision, a local standard of length for a convenient and economical means of standardizing ordinary good quality steel tapes was desirable. The cost of even a few of the tests at the National Bureau of Standards is fairly substantial for only one tape and the usefulness of such a tape for accurate work under conditions of everyday use is necessarily limited to a few months at the most.

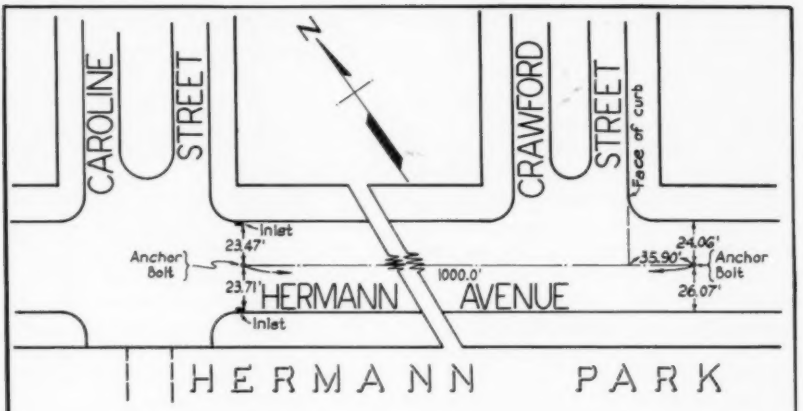
There are tapes and wires manufactured which are designed to compensate for varying conditions of temperature and pull. One such type provides a special scale at the end, graduated to mark the standard length at different temperatures with a fixed pull. Except at the standard temperature, such a tape is accurate only at the end marks. Another type of tape or wire is equipped with a special thermometer which is graduated to indicate the amount of tension to be applied to the spring balance to obtain the standard length when the tape is supported throughout. Such tapes ordinarily carry only three graduation marks. Both types of compensating tapes require special handling and are fairly expensive. Their greatest usefulness is in measuring off accurate distances on the ground without the necessity for making calculations in the field.

Method of Standardizing Steel Tapes

The improvised method of standardizing steel tapes which was adopted 12 years ago by the Houston Lighting & Power Company's Engineering Department and has been continued in use to the present time is simple, relatively inexpensive, and yields satisfactory results. It is described here in some detail only in order that other interested parties may use a similar procedure.

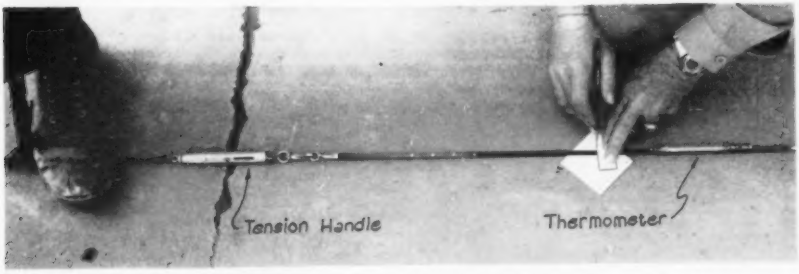
A 1,000-foot base was measured off with the Lo-var tape on a little-used (at that time) and level stretch of pavement, as indicated in figure 1. Each end was marked with a drive-in anchor bolt. This is a galvanized bolt driven flush with the pavement through a lead sleeve inserted in a drill hole.

The procedure is to start the taping with the Lo-var at the west bolt, which is marked by a small punch hole, and measure to the east bolt, where a fresh light scratch is made. Then the measuring is carried back to the beginning, where an additional scratch is made if necessary. The same measuring routine is repeated with each new tape being standardized at that time, except that at the end bolts, a small supplemental scale graduated to 0.001 foot is used under magnification to record the difference found there between the scratch made for the Lo-var and the forward end of the steel tape. Only steel tapes which have an extra short section beyond the end graduation are suitable for reliable checking. A spring balance or tension handle and tape thermometer are employed for each tape and a record kept of the temperature for each tape length. The intermediate end markings are made with a hard pencil on squares of white

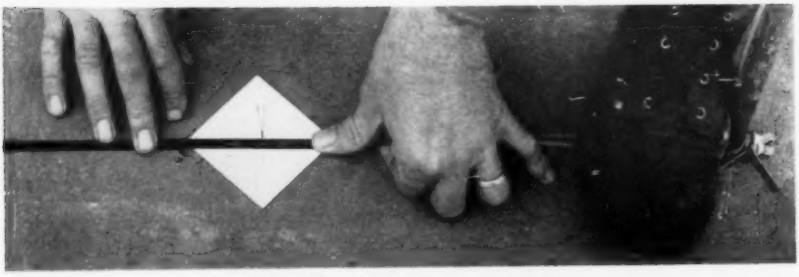


LOCATION OF H.L.& P. CO. BASE LINE
FOR STANDARDIZING STEEL TAPES

FIGURE 1



MARKING FORWARD CONTACT



HOLDING REAR CONTACT

BASE LINE CHECK WITH STEEL TAPE

FIGURE 2

cardboard tacked to the pavement for that purpose, as shown in figure 2. By shifting the lines of measurement only a fraction of an inch and crossing out the preceding marks, several sets of markings can be made without having to change the cards. Cloudy days are preferred for this work, as temperatures are more stable and reliable then.

The same general process of standardization is used when a tape is checked for either two- or three-point support. In this case though, unless the pull is increased to 25 or 30 pounds, it will be found that the temperature at which the tape is "standard" will be very low. The type of support used by the Houston Lighting & Power Company's Engineering Department consists of a short iron tripod topped with a small wooden block bolted in place. Squares of white cardboard are tacked to the blocks and the rear tripod is brought forward by an extra man after each tape length is marked. The initial and final tape ends are transferred from and to the bolts by use of a transit.

The steel tape for which certification was obtained at the National Bureau of Standards for supplemental use with the Lo-var required a pull of 17 pounds when supported horizontally throughout to bring it to standard length at 68° F. Since then, that tension has been used for all 100-foot steel tapes which have been standardized by that process. This has been done for no other reason than to avoid confusion in the field by chainmen. Any other uniform and reasonably stiff pull would suffice, provided that it is the same as that used in the standardization process.

The computation for determining the temperature at which a new steel tape is of standard length under the conditions of support and pull used in the test described here consists of simply dividing the thermal coefficient into the difference between the true length of the base (as determined by the Lo-var) and that obtained by the tape being tested. This gives the amount of temperature change to be applied to the average of the temperatures recorded during the measuring with the steel tape. Table 1 shows the computation which was necessary when standardizing 100-foot steel tape No. 58 at 17 pounds tension and supported throughout.

TABLE 1.—*Example of computation*

	Feet
Corrected length of base as measured and marked by Lo-var	999.9751
Average length of base obtained with tape No. 58	1,000.0275
Difference in length	0.0524
	Degrees F.
Temperature correction $0.0524/(.00000645 \times 1{,}000)$	8.1
Average temperature recorded for tape No. 58	39.97
Standard temperature for tape No. 58 40.0° F. + 8.1° F.	48.1
Check: $8.1 \times .00000645 \times 1{,}000$	0.052

A 1,587-foot length measured with this tape at an average temperature of 98.7° F. will require a *plus* correction of 0.52 foot. A 4,826-foot measurement with an average temperature of 36.5° F. will require a *minus* correction of 0.36 foot. It is necessary to make such computations in the field only when predetermined distances are being staked off.

It would be feasible through calculations and by two or three trial checks on the base to determine the tension required to bring a new tape to standard

length at 68° F. However, it was felt that such a method would give less accurate results than the procedure adopted. Also, the use of tapes having different tensions was considered less desirable for the chainmen.

Of interest to other local engineers who may contemplate using the base shown on figure 1 is the fact that in dozens of measurements with the Lo-var tape the corrected 1,000-foot length has not varied from the distance found each time between bolt centers by more than about 0.015 foot. Therefore, as long as this condition holds, a tape standardized between bolt centers alone should, ignoring other factors, be expected to have an accuracy in the order of 1 : 60,000. The degree of stability found in the pavement at this location may be attributed to the fact that it was several years old at the time the base-line bolts were set.

It is not intended to represent any of the foregoing procedure as an adequate substitute for tape certification by the National Bureau of Standards where it is necessary to do high precision work. It is offered only as a practical expedient for obtaining good quality taping which, with proper safeguards in other respects, should meet all except first-order requirements.

During the past several years, the Houston Lighting & Power Company's Engineering Department survey crews have run hundreds of miles of map control and transmission line right-of-way traverses where position checks between triangulation stations were in the order of 1 : 10,000 if terrain conditions were at all favorable. The usual procedure in such work has been to turn six repetitions in azimuth of each angle (three direct and three reverse) with a transit equipped with a 20″ vernier. Such a transit costs only about 10 percent more than the usual 1′ type. A tension handle and tape thermometer are employed for the chaining, and a record kept of the temperature at 400-foot intervals. This additional equipment can be obtained locally for about ten dollars. It is estimated that after a relatively brief training period for the personnel, the additional time required for making surveys by this method would be about 10 percent more than if no control measures at all were employed. As an economical means of eliminating a considerable element of guesswork, particularly in the adjustment of boundary traverses, it can be strongly recommended.

Attention!

CHANGE IN DATE

Eleventh Annual Meeting

NEW DATE: JUNE 18, 19, 20, 1951

Shoreham Hotel, Washington, D. C.

Electronic Calculators and Their Application to Surveying and Mapping

By DR. WALLACE J. ECKERT

DIRECTOR, PURE SCIENCE DIVISION, INTERNATIONAL BUSINESS MACHINES CORPORATION

THE PURPOSE of this talk is to discuss the various types of electronic calculators and their availability and suitability for surveying and mapping problems. Emphasis will be placed on the type of calculation each machine will perform rather than on the technical discussion of how to solve specific problems.

As with all other types, electronic calculators are classified as continuous or digital, depending upon whether the basic operation is that of measurement or counting. A familiar example of a continuous computer is the tide-predicting machine of the Coast and Geodetic Survey; the most familiar digital machine is the ordinary desk calculator. Generally speaking, the digital machines are more accurate and of more general application. The continuous machines, on the other hand, give a range of solution which is frequently important in exploratory work. The continuous device is in many cases faster than the digital.

In discussing the accuracy of a computer, it is necessary to state "accuracy in what." To say that the accuracy is 0.1 percent without giving more information is not very helpful. In all computational processes accuracy may be lost; this happens when, for example, we divide a number by the difference of two nearly equal numbers. Under these circumstances, each component of the machine might be accurate to 0.1 percent yet the result would still be large and entirely spurious. This problem applies to digital and continuous machines alike, but is more serious for the continuous machines since they have so few figures to start with.

In the rest of this paper I shall discuss only the digital calculators.

In discussing electronic digital calculators I shall differentiate between those that are in factory production and those built in engineering or university laboratories. The factory-made article has the usual advantages of assembly-line production: interchangeable parts, systematized maintenance, and objective evaluation based on wide experience. The machines built in the laboratory, which are usually one or, at most, few of a kind, may embody specifications beyond those for which there is a large commercial market. They frequently involve new elements which have been made to work in a laboratory but have not yet been "shaken down" to where they can be handled under general operating conditions.

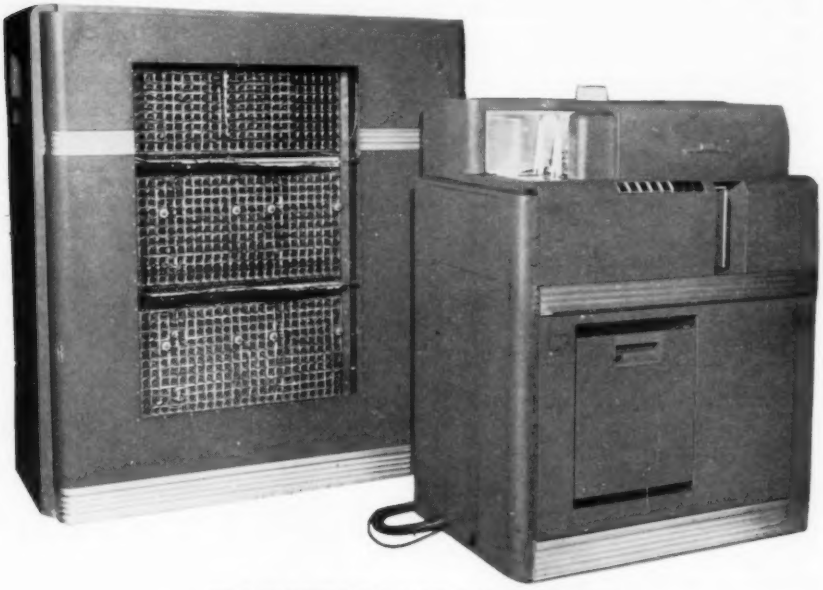
FACTORY-MADE CALCULATORS

Two electronic calculators are now in regular commercial production, both by IBM. The Electronic Calculating Punch (type 604) has been in production since 1948 and several hundred are now in use; the Card Programmed Electronic Calculator was introduced in 1949. Both of these calculators are available throughout the country with service on a monthly rental basis, and on an hourly basis in the regular service bureaus and technical computing bureaus of the Company.

Presented at Tenth Anniversary Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 21–23, 1950.

Electronic Calculating Punch

The 604 reads data from cards, performs on them a sequence of operations, and punches the results in the cards. Cards are read and punched at the rate of 100 per minute. The passage of each card initiates an electronic program of 60 steps, each of which may initiate an operation such as multiplication, division, addition, subtraction, or comparison. The program can be modified by the punching in the card and by the results derived in the calculation. The time required for a transfer or an addition is approximately half a millisecond, and the average time of a 5-digit multiplication is about 15 milliseconds (approximately the time of an oscillation in a 60-cycle power line).



THE ELECTRONIC CALCULATING PUNCH
Exposed section of calculating unit shows wiring to tubes.

Because of the high speed of the electronic calculator, the problem of entering the initial data into the machine and recording the results in usable form is of primary importance. Except in the case of a few special-purpose machines, the success of the calculator is determined largely by these functions. Initial data must be collected from various sources and verified, compared, edited, and rearranged for the particular problem. Finally, the results of the calculation must be studied, rearranged, and printed for dissemination. Since the 604 uses standard punched cards, the familiar auxiliary machines such as the key punch, sorter, collator, reproducer, and printers are available for these functions.

Although there is not time for a detailed discussion of particular problems, I can outline in general terms a type of problem that can effectively use this equipment. Suppose we wish to prepare Loran charts covering a large area. In the

Loran method of navigation, signals are received by the navigator from each of two shore stations. His apparatus indicates the difference in distance from the two stations and he wishes to find from the chart the locus of points having this observed difference. The computer preparing the chart is thus faced with the problem of computing the latitude and longitude of a great many points on a spheroid such that the difference in distance from two fixed points has a given value.

The direct solution of this problem as stated is exceedingly intricate, but when attacked in the inverse order it becomes simple and straightforward. The required area is covered with a grid and the distances from the two stations and their difference are computed for each intersection. The trigonometric formulas for distance on a spheroid are simple and direct; if uniform intervals in the grid are used, only a few trigonometric functions are involved, and the electronic calculator performs the necessary arithmetical operations quickly. When the required quantity, Q, has been obtained for each grid point, the required intersections for the plotting of the contours are obtained by inverse interpolation. The interpolation is performed in one dimension along a meridian or along a parallel in a given region depending upon which direction gives the greater determinateness. Differences of higher order than the first may be used in the interpolation. The calculation may be done by successive approximations; after each approximation, the cards for those cases where adequate accuracy has been obtained are eliminated from the deck. Finally, the results are arranged in the most convenient order for the plotting or for the printing of the final results, and the selected data are prepared as a printed record.

The calculation just described is a good example of what is called parallel computation; corresponding operations are performed on all the grid points before proceeding to the next group of operations. In the serial, or sequential, method all the computations would be performed on one point before proceeding to the next. In some types of calculations, such as the solution of differential equations, it may be necessary to use the sequential method; when this method is not necessary it is usually possible to use simpler equipment for a given problem. The 604 is well adapted to the solution of very large problems by the parallel method and of smaller ones by the sequential method. The length of the sequence that can be performed effectively is limited largely by the amount of internal storage (about 50 digits) for intermediate results.

Card Programmed Electronic Calculator

The Card Programmed Calculator provides facilities for handling longer sequences than the 604; it has greater facilities for storage and for reading operating instructions from punched cards. It consists of a 604 computing unit attached to a standard accounting machine. Data read from the cards by the accounting machine may be read into its own counters, into the 604, or printed on the record sheet. Both numerical data and operating instructions are read from the cards. Each instruction card calls for the corresponding sequence of operations that has been plugged on the 604. In addition to the storage in the 604 there are 80 digits available in the accounting machine and 160 digits in each of one or more special auxiliary units. Obviously, the card program may be as long as desired and may include tables in punched cards. Whereas in the previous example similar operations were performed on a large number of points

before proceeding to the next operation, the Card Programmed Calculator is effective in performing a long calculation for a single point before proceeding to the next.

LABORATORY-BUILT CALCULATORS

Two of the electronic calculators built in laboratories are now in regular productive operation. The first, the ENIAC, was built at the Moore School and installed at the Aberdeen Proving Ground in 1947. As originally constructed, the ENIAC performed a 10-digit multiplication in less than 3 milliseconds; designed primarily for ballistic problems, it will compute the course of a trajectory faster than the projectile travels. It had pluggable sequencing facilities, somewhat over 100 digits of general storage, and 1,200 digits of special storage for mathematical tables. Since then the machine has been modified to give slower, more convenient operation.

The IBM Selective Sequence Electronic Calculator, which has been in productive operation for 2½ years, is the first general purpose electronic calculator of large capacity. It has an internal storage capacity of 400,000 digits, which can be used interchangeably for data or for operation instructions. Data may be read in at the rate of 32,000 digits per minute, recorded in printed form at the rate of 24,000 digits per minute, and recorded in punched cards at the rate of 16,000 digits per minute. At any instant the program of operations can be automatically modified in an arbitrary manner according to the results of the calculation up to that point. The instructions can be stored to perform an almost unlimited number of subsequences which can be called into action as desired. This flexibility simplifies the coding of problems and permits great flexibility in the machine operation. The storage units are all synchronized so that arithmetic operations can be scheduled at the regular rate of 40 per second. These include multiplication with 14-digit factors and addition with 19. Division is 14 by 14.

The calculator is operated by the IBM Department of Pure Science which also operates the Watson Scientific Computing Laboratory at Columbia University. Half of the time of the calculator is devoted to endowed projects in basic research and the other half to suitable projects of government and industry on a service basis.

The endowed projects have included problems in astronomy, optics, hydrodynamics, atomic theory, and nuclear theory. I might indicate, in passing, the nature of the two astronomical projects with which I have been intimately associated. The first was the evaluation of the formulas that give the position of the moon for any required time. This was used to demonstrate the calculator at the dedication and was continued for research purposes. The formulas which give the coordinates for any given time fill several quarto pages. They were converted to a form suitable to control the operation of the machine and stored in the machine: 165,000 digits of storage were used for this purpose. To compute a single position of the moon required approximately 20,000 arithmetic operations and the removal of nearly 2,000 values from a trigonometric table; the time required was 7 minutes.

The other astronomical problem was the numerical integration of the equations for the motion of the five outer planets. This is a set of simultaneous differential equations of the thirtieth order. They were integrated with 16 significant figures over a period of 150 years, and the results have now been discussed

and the integrations are being continued back to 1650 and forward to 2060. Over 5 million multiplications and divisions and 20 million additions and subtractions of large numbers are involved. The printed volume will contain approximately a million and a half figures, representing less than 1 percent of the total number of figures produced and temporarily stored during the calculation.

The problems from government and industry have included problems in engineering, geophysics, nuclear physics, and hydrodynamics. One of them involved the solution of a set of 168 simultaneous linear algebraic equations in 168 unknowns.

During the past year several other electronic calculators have been completed and about a dozen others described in various stages of development. One of those completed is a large-scale calculator that is expected to be in productive operation at the Naval Proving Ground early next year.

The newer machines will vary widely in their general specifications. Each employs one or more elements of recent development: principally storage units employing mercury delay lines; magnetic drums, or cathode-ray tubes; and input-output elements employing magnetic wire or tape. In some of the machines the speed of multiplication will be less than a thousandth of a second. Some will have large internal storage capacity.

SELECTION OF SUITABLE CALCULATOR

With all these electronic calculators in operation or expected to be in operation the man with the computing problem is faced with the question of how he can get his solution most economically and painlessly. Should he use the commercial machines; should he try to obtain access to a large machine; or should he try to secure one of his own. It is not possible to answer this question in general, and in a particular case considerable analysis may be required before the question can be decided. Experience gained over several years in the consideration of the suitability of large and small machines for particular problems indicates that there is a tendency for the amateur computer to overestimate the size of the machine required for his problem. Many problems that have been proposed for the SSEC have been found on analysis to be solved more effectively on the standard punched card machines—even those that do not employ electronics.

Finally, a word should be said about the mathematical analysis involved in the preparation of a problem for a high-speed calculator. Even with the remarkable facilities of the SSEC for facilitating the actual programming of the machine, the fact that the calculation proceeds so fast makes it necessary to think in advance of all sorts of contingencies that may arise concerning the general nature of the solution. With the slower, less expensive machines, many of these can be considered as they arise and the program revised without undue loss.

A POINT TO KEEP IN MIND

" . . . Most journals prefer papers written for the moderate specialist, that is to say, an author should write, not for the half-dozen people in the world specially interested in his line of work, but for the hundred or so who may be interested in some aspects of it if the paper is well written . . . . "—From *Preparation of Scientific Papers* (Royal Society, London).

The Relief Contour Method of Representing Topography on Maps

By PROF. KITIRÔ TANAKA

ENGINEERING FACULTY, KYUSHU IMPERIAL UNIVERSITY, FUKUOKA, JAPAN

MOST maps showing relief by hill shading are ineffective because the treatment of light and shade is not accurate. The eye is acutely sensitive to differences in brightness; therefore the more minute and exact the representation of these differences is, the stronger will be the relief effect. Thus a photograph of an accurately constructed relief model that has been obliquely illuminated usually gives a strong impression of relief.

The method of hill shading described and illustrated in this article was developed by the author[1] to give to a contour map the appearance of detailed relief while preserving the essential character of the contours.[2]

The method is based on a theory concerning the configuration of brightness on a surface obliquely illuminated. This theory enables a numerical value of the brightness at any point on the surface to be calculated. The method can best be understood with reference to figures 1 and 2. Figure 1 shows a hill having a spherical surface represented according to the principle of an ordinary contour map. *A* is a profile, and *B* is a plan; *1* is the horizontal datum plane, and *2* indicates contours. Figure 2 shows the same hill represented by the proposed method. Numeral *3* is the direction of the source of the illumination inclined at an angle of 45° to the horizontal; *4* is the horizontal direction of dip or slope; θ is the horizontal angle between *3* and *4*; *5* is the background of the map shown in a medium tone; *6* indicates contours drawn in white representing slopes having a θ angle of less than 90°; *7* indicates contours drawn in black representing slopes having a θ angle of more than 90°. The thickness of the contour lines varies with the cosine of θ. In other words, if t is the thickness of a contour line at any point on the map, and t_o is the maximum thickness, then

$$t = t_o \cos \theta. \tag{1}$$

The thickness will therefore be greatest when θ is 0° or 180°. When θ is 90°, the thickness of the contour lines is negligible. Contour lines drawn in this way may be called "relief contours."

The choice of the maximum thickness for the relief contours is somewhat arbitrary, depending to a certain extent on the exaggeration or reduction of the relief effect required.

Let the scale equivalent of the vertical interval be d_o and let γ be the dip

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[1] The author acknowledges with gratitude his indebtedness to the Imperial Academy, Tôsyôgû Memorial Society, Japan Society for the Promotion of Researches, and the Scientific Research Fund of the Ministry of Education for their grant in expenditures.

[2] Another method, the "Orthographical Relief Method," was previously proposed by the author (*Memoirs College of Engineering, Kyûsyû Imperial Univ.*, Vol. 5, No. 3, 1930, pp. 121–143 [in English]; see also Kitirô Tanaka: The Orthographical Relief Method of Representing Hill Features on a Topographical Map, *Geogr. Journ.*, Vol. 79, 1932, pp. 213–219).

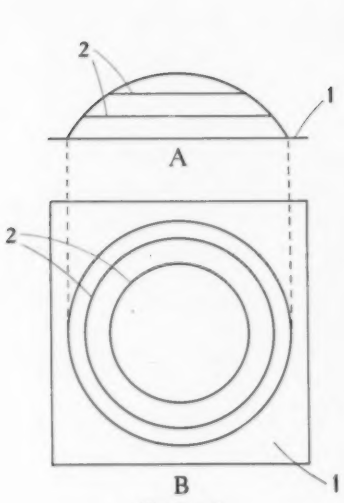


FIGURE 1

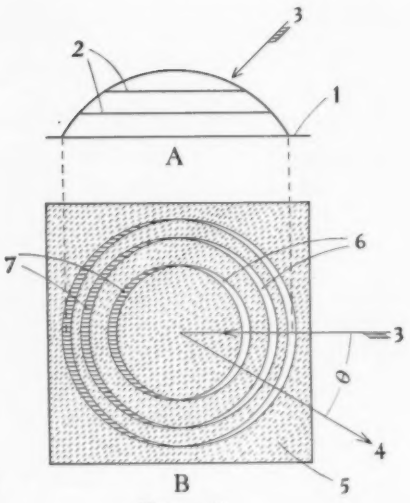


FIGURE 2

angle of a small or elementary area of constant slope, then d, the horizontal spacing of the contours representing this slope, can be expressed by

$$d = d_o \cot \gamma. \tag{2}$$

In the method being described,

$$t_o = k\, d_o, \tag{3}$$

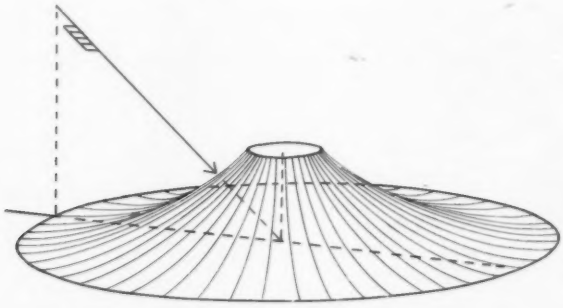
where k is a constant referred to as the "line factor."

Regardless of the best value for k (to be discussed later in this article), it should be obvious that when t equals d, the relief contour lines will merge. Hence from equations (1), (2), and (3), this situation will begin when cot γ equals $k \cos \theta$ regardless of the vertical contour interval. For example, if k equals 1 and θ is 0° or 180°, the relief contour lines will merge for all slopes in these directions greater than 45°, and when k equals 1 and θ is 60° or 120°, merging takes place when the dip angle becomes 63½°. However, as will now be demonstrated, this limitation of the method is not as a rule serious for most types of topography.

THE EFFECTIVENESS OF THE METHOD

Figure 3*A* shows a symmetrical solid somewhat resembling a volcanic cone in perspective, and Figure 3*B* the same solid by relief contours. It will be observed that 3*B* resembles a vertical photograph of a relief model made by placing cardboard layers one above the other.[3] Figure 4 consists of two oblique photographs, taken by the author, of the Kirishima volcano group near Kagoshima in Kyushu, Japan. The topography can be easily visualized. It is of physiographical interest that the volcanic cone numbered *4*, the Sinmoedake, which means literally "a newly burned peak," is the latest eruption. It is therefore, as the photographs

[3] According to Raisz (Erwin Raisz: General Cartography, New York and London, 1938, Fig. 90 [on p. 145]), a somewhat similar method but without the present method's refinement in theory and practice was published by the British Ordnance Survey in 1866.



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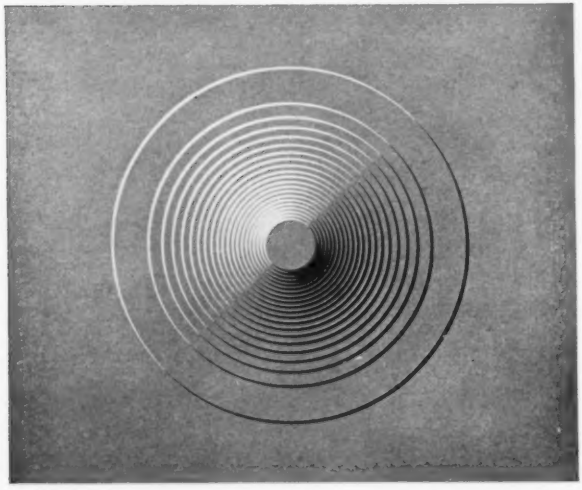


B

FIGURE 3

clearly show, very little dissected as compared with the older cones *2* and *3*. Cone *5* is the oldest eruption and thus is maturely dissected. Figure 5 is a mosaic of vertical photographs, taken from an altitude of 5,000 meters, of this same group of volcanoes, the highest points of which are more than 1,000 meters above the surrounding lowlands. Contrary to what one might expect, the mosaic does not present an easily interpreted relief effect. Figure 6 is part of an official Japanese government topographical sheet, showing the same volcanic group by means of 20-meter contours. Figure 7, which illustrates the method being described, is based on the map shown in figure 6. Note that without destroying the minute and quantitative representation characteristic of the original contour map the relief perception by means of relief contours is greatly enhanced. For example, the physiographic features mentioned above are now strikingly apparent.

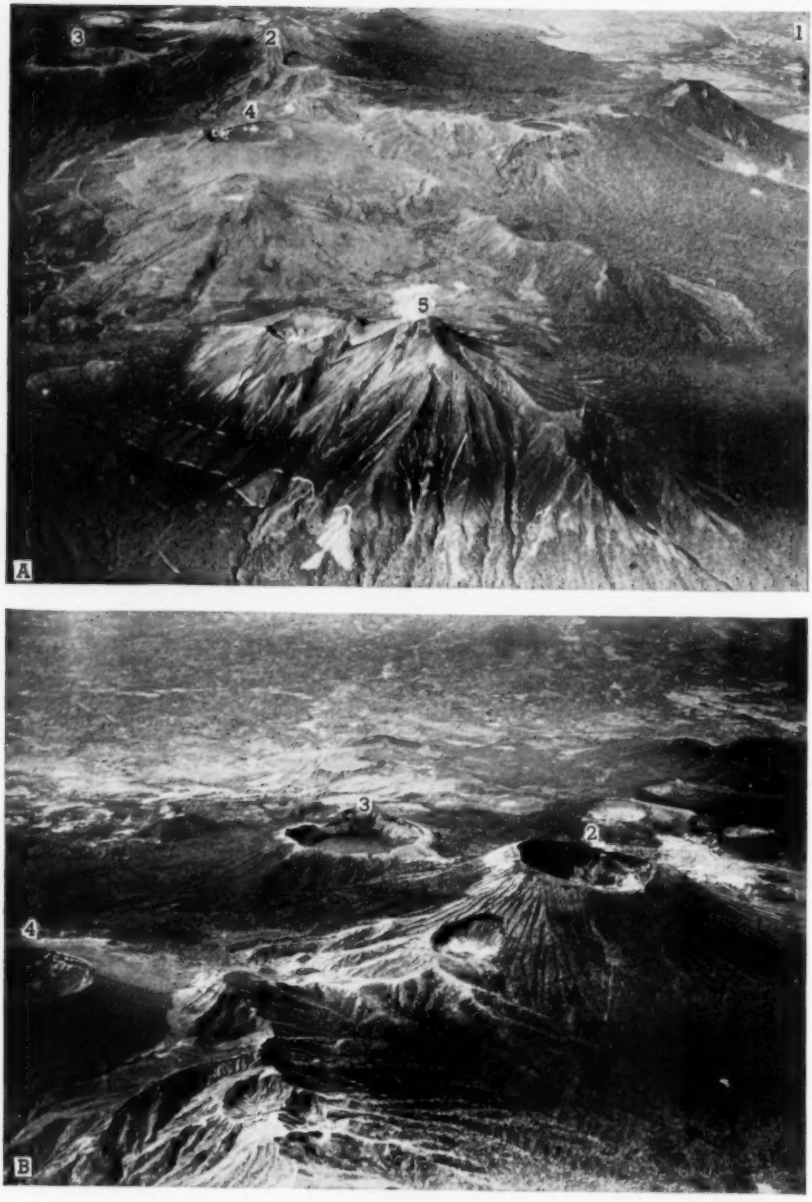


FIGURE 4

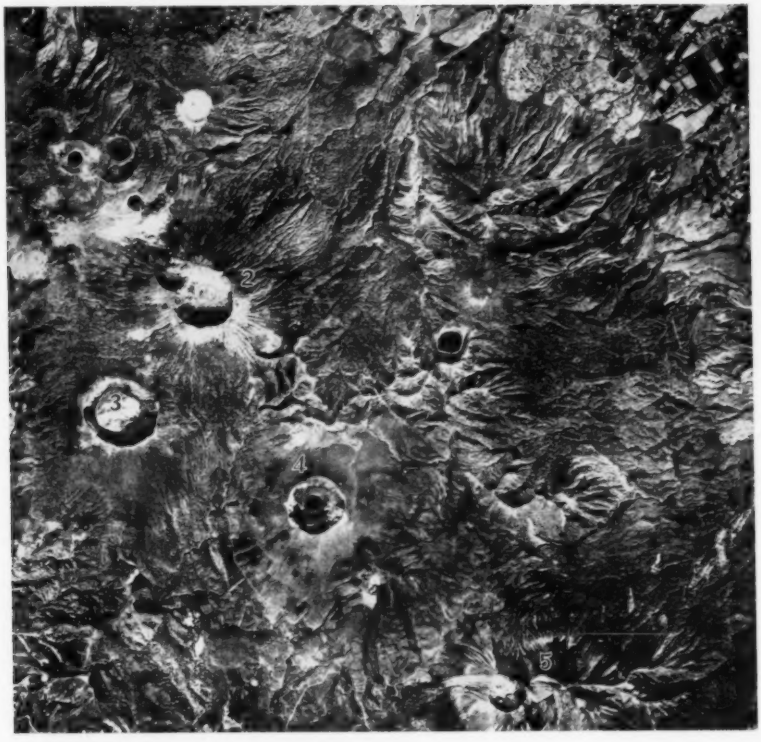


FIGURE 5

METHODS OF DRAWING AND REPRODUCTION

One may reasonably doubt whether such seemingly complicated contour lines can be easily and quickly drawn. A simple and exact method is available, however, that can be satisfactorily used even by an untrained person after a little practice. If the tip of a drawing pen, *8* in figure 8, is filed down so that its thickness is the maximum thickness required in a contour line, and if, as in *Rundschrift* lettering, the pen-point edge is kept at a fixed orientation, *3*, in this case parallel to the assumed horizontal direction of the incident light, then the thickness of the contour line will vary with the cosine of the angle θ.

An original monochrome drawing of a map such as is shown in figure 7 can of course be reproduced by halftone or gravure methods. The author, however, recommends another method, which eliminates the use of a screen and thereby gives a sharper effect to the line detail. In this method at least two printing plates are used, one for the neutral background on which the light contours will be represented by the untouched surface of the paper, and the second for the dark contours and any other detail required. Additional printing plates can be easily prepared if it is desired to print this other detail in different colors. As will be made clear later, a further advantage of using at least two plates is that the rela-

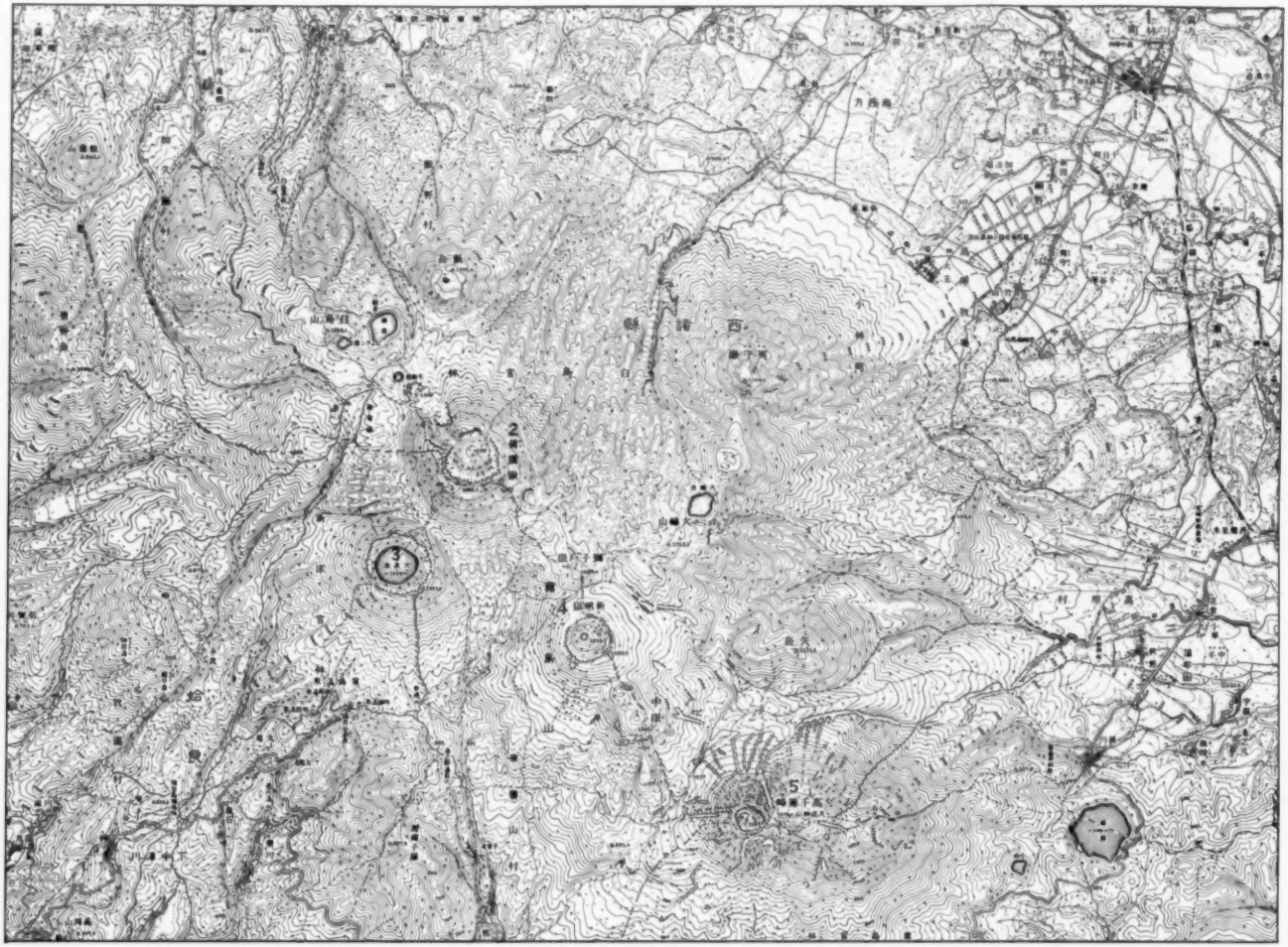


FIGURE 6

FIGURE 6

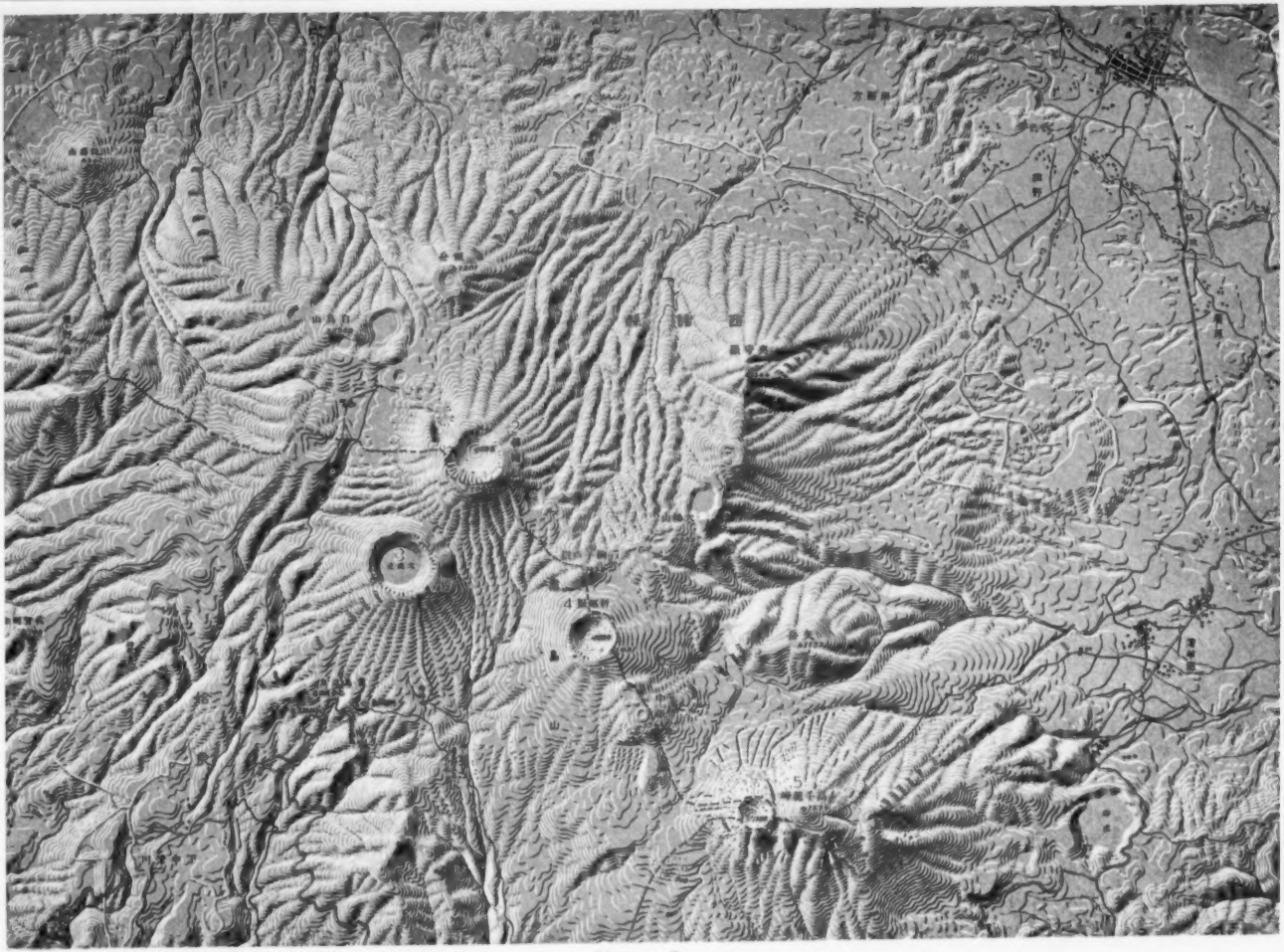


FIGURE 7

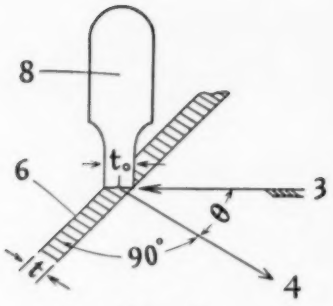


FIGURE 8

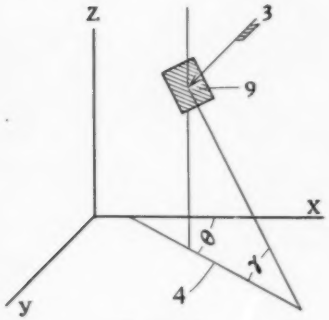


FIGURE 9

tive brightness effects can be more easily regulated, since the background and the dark relief contours are printed separately.

The recommended procedure is as follows: (1) Spray with an airbrush a water color in Prussian blue or ultramarine over the drawing paper on which the map is to be finally drawn. (2) Transfer onto the paper the monochrome base-map compilation, including ordinary contours, drainage, roads, cities, symbols, and lettering. (3) Ink in the dark relief contours in black, and also all other detail except the light relief contours. (4) Ink in the light relief contours in poster white. (5) Make a negative of this drawing on a panchromatic plate, using a red filter, so that the light contours appear as black lines and all other detail, including the background tint, vanishes in transparency. This negative is used to prepare the printing plate for the background and the light contour lines. (6) Make another negative on a panchromatic plate, using a blue filter, so that all detail except the light contours appears as transparent images against a black background. This negative is used to prepare the printing plate for the dark contours and the remaining detail. (7) When the remaining detail is to be printed in colors different from those of the contour lines and the background, make as in (6) as many negatives as are required and opaque out on each the nonpertinent detail.

THE LINE FACTORS

To get the most effective results in printing the map, consideration must be given to the relative brightness of the untreated surface of the paper, the neutral background, and the dark contour lines. If these are denoted by ρ, ρ_o, and ρ' respectively, then, as will be shown in the next section, the required relationships are

$$k = \rho_o/(\rho - \rho_o) \tag{4}$$

and

$$k' = \rho_o/(\rho_o - \rho'), \tag{5}$$

where k and k' are the line factors for the light and dark relief contours respectively.

White paper is never 100 percent bright, and even a black ink line drawn or printed upon it will always have a considerable brightness.[4] Some suitable com-

[4] Means are readily available for measuring the relative brightness of papers and inks applied upon them, as in the use of the "Lagolio Farben Tafel."

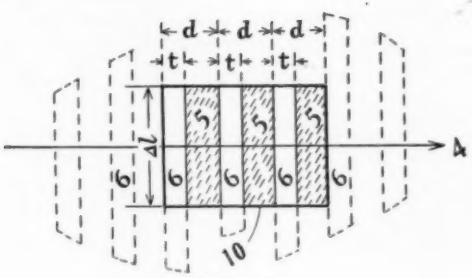


FIGURE 10

binations of brightness with their resulting line factors are shown in the following table:

	Brightness (Percent)			*Line Factors*	
Tone	ρ	ρ_0	ρ'	k	k'
Dark	80	40	2	1.00	1.05
Medium	85	45	5	1.13	1.13
Light	90	50	10	1.25	1.25

On the other hand, it may be desirable to choose a particular value for k from such considerations as the type of topography to be shown on the map and the desirability of exaggerating or reducing the relief effect. Obviously, when k is 2, the relief effect for gentle slopes will be considerably greater than when k is 1. Thus when k is chosen in this way, equation (4) may be written:

$$\rho_0 = k\rho/(1+k).$$

It follows that if values of ρ and ρ' have been determined and the value of k has been adopted, then ρ_0, the required brightness of the background, and k', the line factor for the dark relief contours, can be computed. This statement is generally applicable whether the relief features are printed in black and white or in some color combination.

THEORETICAL BASIS FOR THE METHOD

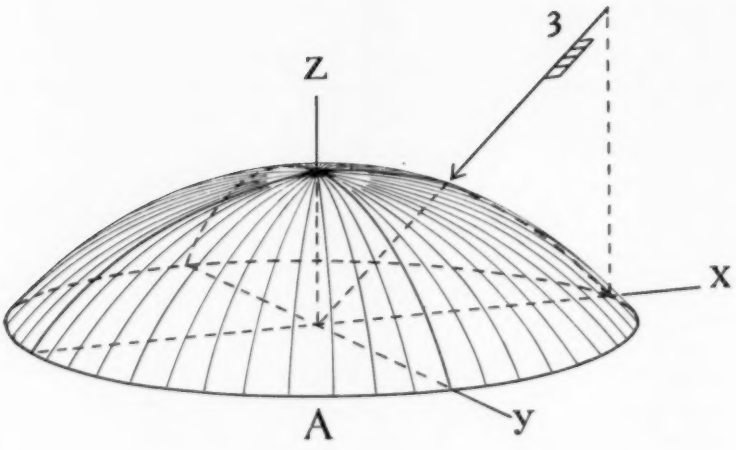
It now remains to compare the relative configuration of brightness of a map reproduced by the method described with that of a relief model of the same landscape, always with the assumption that the model is obliquely illuminated with parallel light inclined at 45° to the horizontal.

To determine the brightness of the model, we assume it to have a perfectly diffusing surface capable of reflecting in all directions the light it receives. If I is the intensity of the incident light, ρ is the reflection ratio of an elementary surface a, ϕ is the angle between the direction of the incident light and the normal to a, and b is the brightness of a, it can be shown from first principles and the theory of photometry that

$$b = I\rho \cos \phi/\pi.$$

The brightest spot on the surface of the model will be when ϕ is zero, and the brightness of this spot will be $I\rho/\pi$. So if B is the relative brightness of a, namely the ratio of b over the maximum brightness, then it follows that

$$B = \cos \phi.$$



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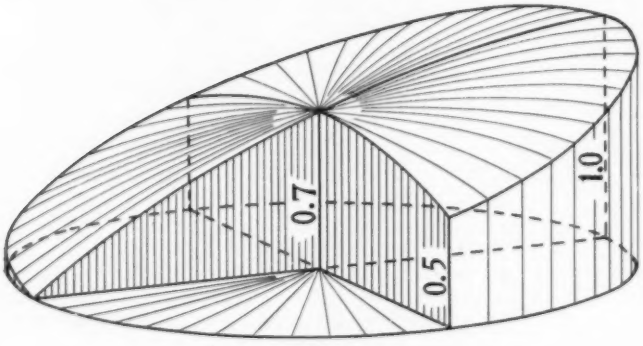

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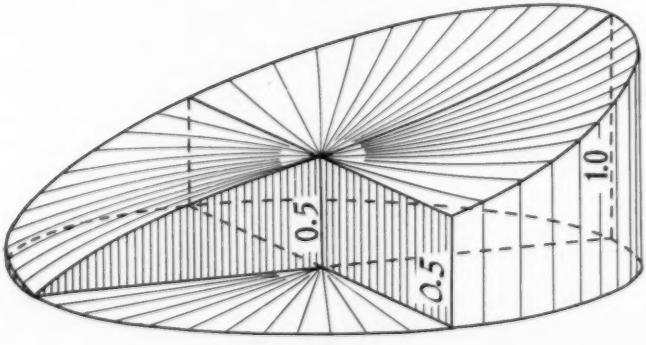

C

FIGURE 11

The relationship between ϕ and the angles γ and θ (fig. 9) can be easily determined by analytical geometry or spherical trigonometry; and when the incident light is inclined at an angle of 45° to the horizontal, it follows that the relationship[5] of B to these angles is expressed by

$$B = (\cos\gamma + \sin\gamma\cos\theta)/\sqrt{2}. \tag{6}$$

To determine the brightness of the map, we may consider a quadrilateral of constant slope on a section of the map on which light relief contours appear (fig. 10). Now since the brightness of a surface is equal to the intensity of the emitted flux, the mean brightness b of this elementary quadrilateral can be obtained by dividing the total emitted flux by the area. Hence, if K is a constant concerning the intensity of the incident ray, n is the number of relief contour lines contained in the area, and Δl is the elementary length of these lines,

$$b = K[\rho_o\, n\, (d-t)\, \Delta l + \rho\, n\, t\, \Delta l]/n\, d\, \Delta l$$

or

$$b = K[\rho_o\, d + (\rho - \rho_o)\, t]/d.$$

Now substituting for d and t from equations (1), (2), and (3),

$$b = K[\rho_o + k(\rho - \rho_o)\cos\theta\tan\gamma]$$

or

$$b = K\sec\gamma[\rho_o\cos\gamma + k\,(\rho - \rho_o)\sin\gamma\cos\theta].$$

Now b should reach its maximum value when the slope is perpendicular to the presumed direction of the incident light. So in the comparison being made the maximum brightness is obtained when θ is 0° and γ is 45°. Thus

$$b_{max} = K[\rho_o + k(\rho - \rho_o)].$$

The ratio $b : b_{max}$ is the relative brightness B_m of the elementary surface on the map, so after substituting for k from equation (4),

$$B_m = \sec\gamma\,(\cos\gamma + \sin\gamma\cos\theta)/2. \tag{7}$$

The same reasoning is applicable to slopes having a θ angle of more than 90°, and, so far as we substitute the line factor k' for k, the relative brightness will be expressed by the same equation (7).

Now it will be observed from equations (6) and (7) that B_m is not identically equal to B. Thus if the relative error in the brightness of the map is denoted by E, then

$$E = 1 - (B_m/B) = 1 - (\sec\gamma/\sqrt{2}). \tag{8}$$

The error E is independent of θ, that is to say, independent of the horizontal direction of slope. This gives a desirable consistency to the map. The maximum value of E, if slopes greater than 45° are not considered, is when γ is 0°. This amounts to 29 percent. The error decreases gradually to a zero value when γ is 45°.

These errors can be visualized in figure 11. A is a spherical surface of which the dip is 45° at the base; B shows the theoretical relative brightness of this surface, and C the relative brightness of the map, the ordinates from the base plane representing the relative brightness in each case. Thus, though the proposed method does not afford an exact facsimile of the theoretical configuration of the brightness of an actual surface, there is a reasonably close resemblance.

[5] Initially developed by the author (*Memoirs College of Engineering* [see footnote 2]).

Preparation of Base Control Maps

By DYSON S. HAMNER

LICENSED SURVEYOR

IN ORDER to provide control and maps for seismic work over large, isolated areas, as in the case of exploration for oil in Wyoming and Montana, some oil companies have found that the triangulation control established by the U. S. Coast and Geodetic Survey provides the fastest and most accurate means for determining horizontal positions and elevations.

The existing triangulation in these localities is broken down into a network of triangles with sides approximately 6 miles long. These smaller triangles are tied into Government bench marks at frequent intervals, and both horizontal and vertical angles are accurately observed. From these observations horizontal positions can be accurately determined and trigonometric elevations computed to an accuracy of about 5 feet. In Wyoming, for instance, the control maps with which I am familiar were plotted on a scale of 1:31,680 and showed the rectangular coordinate lines of a transverse Mercator grid projection, as determined by the Coast and Geodetic Survey. Each of these control, or strip, maps was approximately 3 by 8 feet in size. After the rectangular grid was plotted, it was necessary to compute the coordinate positions of several geographic locations on each map in order to plot accurately lines of latitude and longitude in their true relationship to the rectangular grid. The coordinate positions of triangulation stations were then determined and plotted on the map, and the elevations of the stations shown.

The control map was then ready to be used to determine the locations and elevations of the seismic shot points. This may be accomplished by stadia traverse between triangulation stations, by stadia traverse between three-point locations within the triangulation net, or by three-point locations alone. A three-point location is usually solved graphically by the use of a three-arm protractor. Its elevation is obtained by applying the scaled distances and the observed vertical angles to the locations of the triangulation stations used for the three points. In addition to determining the coordinate positions and geographical locations of shot points, it is necessary to establish their relationship to land or property lines. This is accomplished by tying as many section corners or recorded monuments into the triangulation net as is necessary to permit the draftsman to plot accurately the position of the land net with respect to the grid control.

This method of mapping and control has been in operation in Wyoming and Montana for about 5 years. Some work has been done by using land nets and survey lines for control; but, in this particular area, modern land-survey information is meager and the necessity for determining daily the positions of from 5 to 10 locations, with elevations, over a line 2½ to 5 miles long presents difficulties.

OFFSHORE BASE MAPS

The basic control provided by the Coast and Geodetic Survey has also been used to supply control and maps for offshore seismic work, as in exploration for oil in waters adjacent to the shores of California.

Paper read at General Meeting, Los Angeles Section, American Congress on Surveying and Mapping, June 24, 1949.

The general method of mapping is similar to that used inland, with certain variations. The inland maps are all of the same size and scale, cover equal intervals of latitude and longitude, and are oriented north and south. On the other hand, the maps provided for offshore work are oriented in such a manner as to provide coverage of the water area within approximately 6 miles from shore. The base maps were plotted on a scale of 1,000 feet to the inch. With few exceptions, they were 42 inches wide and differed in length according to variations in the shoreline. In order to plot a map that provides maximum coverage of water area and also includes the shoreline and the necessary triangulation control, careful preliminary planning of the layout is essential. Quadrangle sheets on a scale of 1 : 62,500, showing topography, triangulation stations, and other customary features, were used to determine the orientation of the control maps and the position of the shoreline. The projection of a Lambert conformal grid was indicated on many of these sheets. This grid was extended in detail to 1,000-foot squares in areas adjacent to the shoreline. A strip 42 inches wide on a scale of 1,000 feet to the inch was then projected on the quadrangle sheet in such a manner as to cover the shoreline, including all necessary triangulation stations, and also to provide maximum coverage of the outlying water area. The orientation of this strip, which represents the final control map, was then determined by scaling the angle to the lines forming the projection of the Lambert grid. After locating the coordinate position of the center of the proposed map and knowing the direction of the Lambert grid with reference to the side lines of the map, it is then possible to plot the Lambert grid, the shoreline, and the necessary triangulation on the control map.

After the grid lines were plotted, the shoreline was transferred from the quadrangle sheets to the control map as accurately as the difference in scale of the maps permitted. Triangulation stations were then plotted on the map in their coordinate positions as shown in Coast and Geodetic Survey publications. In addition, other control points, such as buildings and lighthouses, were determined by special surveys and indicated on the map. Adequate descriptions of these stations were given to provide identification from boats offshore.

To indicate the intersection of 60-second lines of latitude and longitude in their correct positions with reference to the Lambert grid, it was necessary to compute the coordinate positions of points of latitude and longitude at the top and bottom of the map at intervals of approximately 4 minutes of longitude, the maps as a rule being oriented in a northwesterly direction.

In the few cases in which it was necessary to cover areas 22 miles from shore, maps were oriented at right angles to the shoreline and plotted on paper 54 inches in width. However, these were awkward to handle and difficult to print. Most of the maps were plotted on tracing cloth, but some were on Kodatrace, a transparent medium similar to film. The 54-inch maps were plotted on tracing paper about the weight of Ozalid printing paper. From the standpoint of drafting, this tracing paper was the most satisfactory because it showed pencil lines more clearly, took ink well, and always lay flat on the drafting table, but it lacks the permanence of either tracing cloth or Kodatrace.

❦ ❦ ❦

ELEVENTH ANNUAL MEETING, JUNE 18–20, 1951, WASH., D. C.

Legal Elements of Surveying in the Establishment of Land Boundaries

By CZERNY ANDERSON
LAND SURVEYOR

THE PURPOSE OF THIS PAPER is to bring to the land surveying profession a basic understanding of the legal elements involved in the establishment of land boundaries.

The survey of the public lands of the United States is inseparably associated with questions relating to location and title. Once the public lands have been surveyed, the physical evidence of the monuments established to delineate the boundaries of such lands must stand as the true corners of the lands which they were intended to represent. When properly identified, the monuments so established will control directions and lengths of lines. Subsequent purchasers acquire title to such lands in accordance with these monuments. The physical marks defining the areas conveyed may disappear, but the title remains. Such boundaries may be recovered by survey and laws applicable thereto.

These same principles apply to the establishment of boundaries when the public lands have passed into private ownership. Thus the corners, boundaries, and lines established by authority of the Federal Government upon the public lands control location of the underlying title to private as well as public ownership, where dependent upon such established boundaries.

The Supreme Court of the United States in the case of *Cragin* v. *Powell*, 128 U. S. 691, 696, said:

> "It is a well-settled principle that, where lands are granted according to an official plat of the survey of such lands, the plat itself, with all its notes, lines, descriptions, and landmarks, becomes as much a part of the grant or deed by which they are conveyed, and controls so far as limits are concerned, as if such descriptive features were written out upon the face of the deed or the grant itself."

After boundaries have thus been established by grant or otherwise, it is the function of a land surveyor to retrace and reestablish them. Retracement and reestablishment of boundaries impose upon the land surveyor a duty far beyond his technical skill and require a thorough knowledge and understanding of the legal elements involved, as imposed by law. Ownership and development of land are dependent upon location. The boundary of such ownership is the separation, natural or artificial, which marks the line of division of contiguous lands.

RULES FOR PUBLIC LAND SURVEYS

In 1939 the General Land Office published Circular 1452, entitled "Restoration of Lost or Obliterated Corners and Subdivision of Sections." This is "a compendium of the rules that are applicable within the area of the United States Rectangular Surveys, for the guidance of county and other local surveyors, with explanation of the methods relating to retracements." This circular should be obtained and carefully studied by all land surveyors, as it sets forth basic rules

Presented at Tenth Anniversary Meeting, American Congress on Surveying and Mapping, Washington, D. C., June 21–23, 1950. (Paper read by A. L. Shalowitz in the absence of the author.)

governing the subject. These rules control so long as the title to the lands remains in the Federal Government, and Federal laws control the acts of surveyors operating in accordance with such rules. Once the title has passed to private ownership and the lands are subject to adjudication in the state courts, these rules are advisory only. (*Cordell* v. *Sanders*, 52 S.W. [2d] 834.)

The Land Office circular, under section 1008 of the chapter entitled "Original Records," states:

"The township plats furnish the basic representation of the surveys and the descriptions of all areas therein. All title records within the area of the former public domain are initiated from a Government grant or patent, with description referred to an official plat; the lands so entered are identified on the ground through the retracement, restoration, and maintenance of the official subdivisions."

This circular also gives the following definitions relative to corners established by authority of the Federal Government:

Section 1018.—"An existent corner is one whose position can be identified by verifying the evidence of the monument, or its accessories, by reference to the description that is contained in the field notes, or where the point can be located by an acceptable supplemental survey record, some physical evidence, or testimony.

"Even though its physical evidence may have entirely disappeared, a corner will not be regarded as lost if its position can be recovered through the testimony of one or more witnesses who have a dependable knowledge of the original location."

Section 1019.—"An obliterated corner is one at whose point there are no remaining traces of the monument or its accessories but whose location has been perpetuated, or the point for which may be recovered beyond reasonable doubt, by the acts and testimony of the interested landowners, competent surveyors, or other qualified local authorities, or witnesses, or by some acceptable record evidence.

"A position that depends upon the use of collateral evidence can be accepted only as duly supported, generally through proper relation to known corners, and agreement with the field notes regarding distances to natural objects, stream crossings, line trees, off-line tree blazes, etc., or unquestionable testimony."

Section 1020.—"A lost corner is a point of a survey whose position cannot be determined beyond a reasonable doubt, either from traces of the original marks or from acceptable evidence or testimony that bears upon the original position, and whose location can be restored only by reference to one or more interdependent corners.

"If there is some acceptable evidence of the original location, that position will be employed in preference to the rule that would be applied to a lost corner.

"No decision should be made in regard to the restoration of a corner until every means has been exercised that might aid in identifying its true original position."

The foregoing definitions, rules, and regulations are applicable to the reestablishment of private as well as public boundaries. Thus it can be said that a land surveyor, in retracing, establishing, and reestablishing boundaries, acts in the capacity of investigator and fact finder. Such investigations are of necessity informative and determinative in their functions. They require the skill and judgment of a land surveyor, together with a thorough knowledge of what constitutes factual data incident to a boundary determination and the various kinds of evidence necessary to prove or disprove the facts discovered.

All land-boundary surveys are subject to judicial review. In the retracement and reestablishment of boundary lines defining lands which have passed into private ownership, surveys and maps incident thereto are merely opinions of the surveyor and fact finder and are not conclusive upon the parties concerned. The

surveyor should bear in mind that courts and juries may be required to follow his tracks; therefore, it is incumbent upon him to govern his acts by the same rules that will govern theirs.

It is the duty of the land surveyor to support his establishment of a boundary by all available factual data incident thereto derived from investigations as to occupation, fences, boundary disputes if any, evidence of original survey, record search (federal, state, and county offices), and county survey records and inquiries of local surveyors and adjoining owners. A real understanding of the basic rules of evidence is necessary to prove such accumulated facts true or false.

EVIDENCE

Black's Law Dictionary states, "The word 'evidence,' in legal acceptation, includes all the means by which any alleged matter of fact, the truth of which is submitted to investigation, is established or disproved."

The distinction between proof and evidence is clear: Proof is the establishment as to the truth or falsity of a certain fact. Evidence is the means by which the proof is secured. The several forms of evidence include: Relevant, competent, material, direct, circumstantial, affirmative, primary, secondary, and hearsay. All of these cannot be covered in this paper; however, the following are set forth as a guide in the establishment of boundaries:

Primary evidence.—That kind of evidence which, under every possible circumstance, affords the greatest certainty of the fact in question.

Secondary evidence.—That evidence which becomes admissible when the primary evidence of the fact in question is lost or not available.

METHODS OF ESTABLISHING BOUNDARIES

Once the title to public lands has passed into private ownership, establishment of a boundary is dependent upon location on the earth's surface, and location controls ownership.

Retracement surveys are dependent upon the method employed at the time the retraced lines were originally established. It is mandatory that the surveyor follow the exact tracks of the original surveyor, securing factual data and evidence to support the retracement. The following methods are most commonly used in the establishment of boundaries:

1. *Agreement*

(*a*) By written agreement containing words of conveyance.

(*b*) By parol agreement. It appears to be a well-settled principle of law that a disputed boundary between lands of adjoining owners may be permanently and irrevocably established by a parol agreement of such adjoining owners.

2. *Estoppel*

The location of a boundary line is not considered as affecting title to the land and therefore may be established by estoppel.

3. *Practical Location*

"Practical location is but an actual designation by the parties on the ground of the monuments and bounds called for in their deeds, and one adjoiner cannot make a practical location without the other. Cooperation and agreement between the adjoiners is essential to a practical location, and the mere fact that an adjoiner knew of the survey and saw the actual setting of the stakes is insufficient to establish a practical location in the absence of

proof that he agreed to the line or that improvements were made according to the survey." [1]

4. *Recognition and Acquiescence*

(*a*) *General.*—"Recognition of, and acquiescence in, a line as the true boundary line of one's land, not induced by mistake, and continued through a considerable period of time, affords strong, if not conclusive, evidence that the line so recognized is in fact the true line. And it has been held that a boundary may be established by recognition and acquiescence, although neither of the parties intended to claim more than his deed gave him. However, a mere license or passive acquiescence on the part of a landowner in an encroachment of his adjoiner will not conclude him.

(*b*) *Mutual mistake.*—"Where a line is recognized and acquiesced in through a mutual mistake the parties will not be estopped to assert the true division line.

(*c*) *Ignorance of encroachment.*—"Likewise, one who has no knowledge that the building of an adjoining owner encroaches on his lot cannot be held to have lost his right by acquiescence in such occupation no matter how long continued." (*Corpus Juris.*)

5. *Private Survey*

"Boundaries may be established by private survey, but such an establishment is at most effective only among the parties thereto. While both the national and state governments have enacted laws providing for the official survey of lands and the proper preservation and recording of such surveys, such laws do not preclude the establishment of boundaries by unofficial surveys." (*Corpus Juris.*)

LEGAL STATUS OF THE SURVEYOR

As stated, a land surveyor acts in the capacity of an investigator and fact finder whether he makes an original or a retracement survey. In the case of an original survey, investigations are necessary in order to secure control as to location with reference to other surveys; factual data are accumulated to support that survey control and its relationship to record ownership. In retracement surveys the investigations are quasi judicial, for herein the land surveyor acts in an official capacity in accordance with the laws under which he is licensed. In actions at law to determine boundaries, the land surveyor becomes an important witness when qualified by training and experience to gather the relevant factual data pertaining to surveys. A general knowledge of his status as a surveyor will aid him in his conduct.

Surveyors.—"A surveyor may testify to facts within his personal knowledge relating to the lines, corners, or monuments of lands, but not as to the location of a line which he has run from an ancient map, where he had no means of verifying his survey, nor can he testify as to his intention in running the survey or give his opinion, as a surveyor, as to the true location of the land in controversy. Surveyors may properly be questioned, as experts, on subjects with which they are peculiarly acquainted, and which cannot be made known to the jury except by such testimony. And they may be permitted to testify that a straight line cannot be run without the aid of an instrument. So a surveyor may illustrate his testimony by the use of charts and plans prepared from actual knowledge and surveys. He can, however, testify only in regard to facts, never in regard to conclusions of fact or of law, as such matters are for the determination of the jury or the court as the case may be." (*Corpus Juris.*)

Surveys.—"Surveys of lands whose boundaries are in controversy are generally admissible, but authority to make them must be shown; and it is further essential that the survey shall have been made as the statute directs; and in no case is a private survey

[1] SKELTON, RAY H.: The Legal Elements of Boundaries and Adjacent Properties, *The Bobbs-Merrill Company,* 1930, Indianapolis, p. 362.

admissible against one who, or whose privies, took no part therein, or had no notice thereof, or to contradict or modify a government survey. Resurveys, when made agreeably to the requirements of law, are also admissible to show boundaries." (*Corpus Juris.*)

FENCES AND ESTABLISHED CORNERS

In the establishment of boundaries and in the retracement of original surveys, fences play an important part. To a land surveyor who has executed large-scale retracements, they are monuments of occupation. Settlement of public lands often followed survey; fences were constructed when corners, monuments, and lines were clearly evident and thus lead the land surveyor to the control required to retrace the original survey.

Fences.—"A hedge, structure, or partition erected for the purpose of enclosing a piece of land, or to divide a piece of land into distinct portions, or to separate two contiguous estates." (*Black's Law Dictionary.*)

"Ancient fences used by a surveyor in his attempt to reproduce an old survey are strong evidence of the location of the original lines and, if they have been standing for many years, should be taken as indicating such lines as against the evidence of a survey which ignores such fences and is based upon an assumed starting point. It is said that a long-established fence is better evidence of actual boundaries settled by practical location than any survey made after the monuments of the original survey have disappeared. Accordingly, a fence erected on a surveyed line shortly after the land has been surveyed may serve as a monument to control courses and distances or a subsequent survey after the stakes of the original survey have disappeared." (*American Jurisprudence.*)

The establishment of a corner point or line in surveying indicates a position fixed on the earth's surface by the surveyor which had no previous existence, at least of record. Once established, these points and lines become original control.

Established corners.—"A corner established by government surveyors with reference to which patents have been issued should be accepted as the true corner and give controlling effect without regard to whether or not it was originally located with mathematical exactness. An established corner between sections of land must govern even as against other surveys or evidence tending to prove that such corner should be located elsewhere. Accordingly, an established corner will control the field notes of the survey where a discrepancy exists between the field notes and such corner as is marked on the ground. Where, however, a corner cannot be located by clear and satisfactory evidence, the field notes may then be taken as the next best evidence as to the location of boundaries." (*American Jurisprudence.*)

LEGAL DEFINITION OF LAND SURVEYING

The profession of land surveying is little understood by the lay public. It deals with location; and almost all activities of mankind are dependent upon location—railroads, highways, buildings, power lines, and property lines, to name but a few. As population and land values increase, location requires greater precision; mapping becomes more complicated.

The California Land Surveyor's Act gives the following very clear definition of what constitutes land surveying:

"A person practices land surveying within the meaning of this chapter who, either in a public or private capacity, does or offers to do any one or more of the following:

(*a*) "Locates, relocates, establishes, reestablishes, or retraces any property line or boundary of any parcel of land or any road, right-of-way, easement, alignment, or elevation for any of the fixed works embraced within the practice of civil engineering, as described in Chapter 7, Division 3, of this code.

(*b*) "Makes any survey for the subdivision or re-subdivision of any tract of land.

(*c*) "By the use of the principles of land surveying, determines the position for any monument or reference point which marks a property line, boundary, or corner, or sets, resets, or replaces any such monument or reference point.

(*d*) "Determines the configuration or contour of the earth's surface, or the position of fixed objects thereon or related thereto, by means of measuring lines and angles and applying the principles of trigonometry.

(*e*) "Makes geodetic or cadastral surveys.

(*f*) "Determines the information shown or to be shown on any map or document prepared or furnished in connection with any one or more of the functions described in subsections (*a*), (*b*), (*c*), (*d*), and (*e*)."

SUMMARY

All of the foregoing comments and references are for the guidance of land surveyors and those persons whose activities are related to land surveying. The legal elements are basic when applied to the original establishment of boundaries by the Federal Government and have been emphasized in keeping with their importance.

The land surveyor should bear in mind that the general rules of evidence apply. He should gather all available evidence to support his land location. Upon completion of all necessary retracement surveys, a written survey report should be submitted, setting forth all factual data incident to the survey, together with a detailed statement of the evidence secured to prove the facts, including the sources.

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Surveyors' Institute Conducted at Wisconsin

THE PROBLEMS of land surveyors were discussed at a 3-day Surveyors' Institute, at the University of Wisconsin, November 28–30, under the direction of the College of Engineering and the Extension Division. Twenty-nine land surveyors attended these sessions, which included talks by authorities from the engineering faculty, state agencies, and private practice.

The subjects discussed included "Developments in Surveying Instruments" (with a demonstration of new-type instruments) by W. M. Haas and H. A. Kallsen, instructors in civil engineering; "Aerial Mapping in Land Surveying" by Talbert Abrams of Lansing, Mich.; "Aerial Photographs in Land Surveying" by Prof. E. C. Wagner of the civil engineering faculty; "Legal Problems in Land Surveying" by Perry J. Armstrong, Madison attorney; and "Land Subdivision and Subdivision Laws in Wisconsin" by M. W. Torkelson, secretary of the Wisconsin State Planning Board.

Ray S. Owen, professor emeritus of civil engineering, related his experiences in land surveying, and E. F. Bean, state geologist, told how the work of the U. S. Geological Survey can help the surveyor.

The planning of the Institute was under the direction of Prof. L. F. Hillis of the University Extension Division and Prof. E. C. Wagner of the College of Engineering.

—LOUIS W. BRIDGMAN

Progress Through Local Professional Surveying Societies

Foreword

By JOHN P. GOGGIN
CIVIL ENGINEER, CLARE, MICHIGAN

WHEN asked to join a local land surveyors' society, the surveyor generally asks what benefits he might expect. We, of the Michigan Society of Registered Land Surveyors, believe we are now in a position to answer, at least in part, this vital question.

At one time, registered land surveyors in Michigan were organized as a minor branch of the Michigan Engineering Society. The agenda of most of the conventions of the Michigan Engineering Society centered around engineering problems and data other than land surveying. It seemed advisable, therefore, to organize a Michigan Society of Registered Land Surveyors that would place property surveyors' problems above all others. This was done, under the able leadership of such men as Messrs. William B. Williams, Claude Postif, George Henning, and the late S. F. DeLaMater.

The growth of the organization and the dissemination of its ideas and ideals were seriously retarded by the depression and World War II. However, after World War II the profession of land surveying took a new lease on life in Michigan. It was aided no little by the fine work of the Property Surveys Division of the American Congress on Surveying and Mapping, under the direction and leadership of men like Messrs. Sol A. Bauer, William C. Wattles, and others.

Using the registration list of the State of Michigan to seek prospective members, our organization canvassed every registered land surveyor, and the Society began to grow.

After several annual meetings, we realized that the annual convention method was not quite the way to approach and attack our various local problems. As a result, local chapters were organized: one in Detroit, to handle the urban and local problems; and one in the northern part of Michigan, to handle the small-town and open-country surveying problems. A concerted effort was made to inform judges, attorneys, registers of deeds, and realtors of the surveyors' problems and objectives. We invited nonmembers to attend meetings, and we asked men who enjoy prestige in their own professions to address us on pertinent subjects. In turn, we offered our services by sending representatives to address bankers', bar, and realtors' associations.

Land surveyors have benefited greatly from the mutual understanding resulting from these efforts. At a recent meeting of the Northern Chapter of the Michigan Society of Registered Land Surveyors, Judge Donald E. Holbrook gave his definition of a profession as one that entails, primarily, service to the public. He also stated that the Michigan courts recognize surveying as one of the oldest of the professions and that they are willing to concede this status insofar as the professional activities of the surveyors warrant it.

After Judge Holbrook's talk, the following three papers were presented. They are examples of the coordination being established between the surveyor and some of those vitally interested in his work, and indicate the progress that can be made by a professional society. All that remains is for us to devise professional, ethical methods of dealing with the public at large. Based on past experience with the Michigan Society of Registered Land Surveyors, I feel that we will be able to do this in the near future. The sooner the registered land surveyors in each state, possession, or territory of the United States organize themselves on a purely ethical, professional basis and carry out a program such as we have done in Michigan, aided of course by sister state societies already in operation and the Property Surveys Division of the American Congress on Surveying and Mapping, the

sooner will they achieve the status that is much desired and discussed whenever two or more surveyors get together.

The Surveyor as an Expert Witness

By HAROLD B. HUGHES
PROSECUTING ATTORNEY, CLARE COUNTY, MICHIGAN

I HAVE BEEN ASKED to speak to you on the value, to an attorney, of a competent surveyor as an expert witness.

Sir Herbert Tree once was called as an expert witness in a court case in London.

"Now, Sir Herbert," said the counsel for the company being sued, on cross-examination, "You say you saw the accident; where was the plaintiff standing when you saw the accident?"

"Well, I-ah think—," began the famous Sir Herbert.

"We don't want to know what you think," shouted the cross-examiner. "We want the facts."

"In that case," said Sir Herbert, "I'm afraid I can't testify. I can't talk without thinking; I'm not a lawyer."

I really wanted to point out to you, with that little story, that the expert witness is one who must do a considerable amount of thinking, and be qualified in the field for which he is selected to act as an expert witness.

We of the legal profession have called upon doctors, handwriting experts, criminal pathologists, and many members of other professions to give expert opinions in their fields. A competent surveyor may also be called as an expert witness.

NEED FOR EXPERT WITNESSES

Frequently the jury, or the court trying a case without a jury, is confronted with issues that require scientific or specialized knowledge or experience for a proper understanding. Such issues cannot be determined intelligently merely from the deductions made or inferences drawn on the basis of ordinary knowledge, common sense, or practical experience gained in the ordinary affairs of life.

Experts have knowledge, training, and experience which enable them to form better opinions on problems in their particular fields than those formed by unqualified persons. Opinions of expert witnesses are admitted as evidence to help the average juror understand questions which inexperienced persons are not likely to answer correctly without assistance. Issues of this kind are said to create a need to admit as evidence the opinions or conclusions of witnesses who are shown to be especially skilled or experienced in the particular field in question. Although expert opinions sometimes are denounced as misleading and unsatisfactory, they are useful in a variety of cases, and, within reasonable bounds, should be encouraged.

In most instances, the layman is unqualified to give descriptions of land surfaces or the many intricate descriptions of curves and angles which are the province of a competent surveyor. The layman is still less capable of judging between the land boundaries of one parcel and those of another; where lines should be established; where boundaries are located; or various other land problems which are aired in court from time to time. Neither is a jury of rural

farmers nor of city dwellers capable of determining such important issues as the true description of land, roadways, or rights-of-way. On such issues, testimony of one possessing special knowledge and skill is required. In such cases witnesses possessing requisite training, skill, or knowledge, and persons designated as experts may testify not only as to the facts, but may also give their opinions respecting the facts, as far as necessary, to enlighten the jury and to assist the court in rendering a just verdict.

QUALIFICATIONS OF AN EXPERT

Because the testimony of an expert is considered to be the best interpretation of the evidence presented, it would seem that high educational qualifications, or a requirement for an annual control system to insure maintenance of such standards, should be continued for the land surveyor. If he is called as an expect witness, evidence of his qualifications as to schooling, training, experience in the field, or unusual surveying contracts which he has had will tend to convince the jury and the court that the surveyor has every right to testify.

I know from personal knowledge and contact with the surveying profession that your organization is doing everything within its power to have its members maintain a high standard of qualifications. I can also safely say that I would feel free to call on a surveyor who has the present required standards of education to testify as an expert at any time, because I know that his opinion would be of outstanding value in determining matters of land-division problems.

When a surveyor is called as an expert witness, he may bring his surveying notes into court and, in most instances, use them as reference in testifying. He may use blackboards or other facilities in his field to present diagrams and other information which would be useful to the court and the jury. It is quite possible that, as an expert, he might be called upon to answer a question on a hypothetical case; that is, he might be given a certain set of facts and asked to render his opinion with a yes-or-no answer.

The expert witness can be subjected to rigid cross examination. Knowledge of his profession may be thoroughly tested by the cross-examining attorney, who might try to overthrow the weight of his opinion. I have often seen medical experts so examined. However, all that can be expected of the expert is that he honestly state his opinion based on his education, experience, and knowledge.

An attorney who appreciates the competence of a surveyor can use him as an expert witness on innumerable occasions. It is the duty of the lawyer and the court to see that honesty and fairness are used in determining the facts in every case. The assistance of the expert who observes these principles will always be appreciated.

The Surveyor's Contribution to a Good Property Title

By WILLIAM A. HENDERSON

REGISTER OF DEEDS AND COUNTY CLERK, CLARE COUNTY, MICHIGAN

I HAVE often wondered whether property owners know how many public officials and professional men have a part in the recorded titles to their real estate.

In Michigan, one of the so-called public-land states, title to land was vested in the Federal Government. When land was sold to an individual, the patent

was signed by the President and the Secretary of State of the United States. When a land grant was made to the State, such as railroad land, canal land, primary-school land, or a grant to the State for the benefit of colleges that teach agriculture and the mechanical arts, it required an act of Congress. When sold by the State, the Governor and Secretary of State signed the patent.

The first professional man to enter into the transaction was the surveyor. His job was difficult because it meant he had to go into the wilderness and remain there for months. There were no roads and no known landmarks. Many of the surveyors had only their compasses to assist them in finding their way back to civilization. Surveys of public-land subdivisions were begun in Clare County in the late 1830's and completed in the 1850's.

Various county officers are concerned in most transactions that involve land ownership. When a person received a patent to a tract of land, he had to have it recorded at the office of the register of deeds, where all subsequent changes of ownership are also recorded. Before the property could be occupied, surveys by the road commission were often necessary for the location of roads. All recorded property is also listed by the county treasurer on the tax roll for taxation. Whenever land is sold, there should be certification by the county treasurer that there are no unpaid tax claims. When a recorded owner dies, the estate must be probated in Probate Court before real estate can be transferred to a new owner. In case of litigation involving land, the county clerk's office must record the suit, and the sheriff's office must serve notices upon the interested parties.

Before taking possession of or improving any parcel of land, persons are advised to secure the services of a surveyor to find the boundary lines of the property. All kinds of trouble, and even law suits, are known to have resulted from the fact that buildings have been erected either partly or wholly on another person's land simply because the property owner did not hire a surveyor to establish the boundaries of his land.

One of the essential things to obtain in real estate dealings is an abstract, that is, a history of the title to the land. It is not a guarantee of the title. The abstract is prepared by a professional, independent abstractor and/or the register of deeds in counties that own the abstract books (which is the case in this county). After an abstract has been prepared, I strongly recommend that it be turned over to an attorney for his opinion. Quite often, inconvenience and litigation may be avoided by obtaining his opinion and following his advice.

It is very important that an abstract be prepared to cover all the land that comprises the real estate involved, and it is a great satisfaction to the abstractor to know that the description is based upon a metes-and-bounds survey that has been made by a competent surveyor. Such a description usually is accepted without question. However, in too many cases, incompetent individuals have measured small parcels of land, such as city lots, with cloth tapes. Usually, the greater the distance from the starting point in such cases, the more incorrect are the measurements.

Descriptions, and their inclusion in abstracts, for parcels of land in the interior of a 40-acre tract could be materially improved if the starting point could be established by reference to both corners of the "40" line. Many of the "40's," which are quarters of quarter-sections, contain either more or less than 40 acres. Consequently, small, independently surveyed parcels may overlap or fail to join, especially in the west and north "40's" of each township. Another problem for

the abstractor is the frequent slight difference between the measurements shown in the original subdivision survey and those shown in resurveys. Quite often conditions existing at the time of the original surveys made exact work very difficult. Resulting errors, although they may be small, will cause much trouble in urban areas where houses are spaced 50 feet or less apart.

I suggest that quarter- or eighth-section lines be shown in red on plats, particularly when the plats embrace more than one governmental description. These descriptions quite often appear in more than one chain of titles, and it is very helpful to be able to determine, from a glance at the plat, which particular "40" or other tract contains any particular lot or lots. I also recommend that whenever a plat is made for land surveyed by metes and bounds and when an abstract is available, the description shown therein be checked and any discrepancies noted.

I wish to thank Mr. Goggin for the honor and pleasure of being here and wish to assure all of you the fullest cooperation in case you should have any work to do in this county.

The Realtor and the Surveyor

By RUSSELL A. POINTER

PRESIDENT, MICHIGAN REAL ESTATE ASSOCIATION

AS PRESIDENT of the Michigan Real Estate Association, I bring you greetings from the realtors of our State. The realtors of Michigan are enjoying a year in business far better than average. Nationally, construction has been started on as many buildings this year as last year, and last year the number was an all-time record. We are sure that, if our business is good, yours also must be good, inasmuch as we both are service organizations dealing with land.

We also have another similarity in our organizations. In the real estate business, not all brokers are realtors. We realtors like to think of ourselves as the cream of the profession. The term "realtor" is copyrighted. To use it, one must meet certain educational standards and subscribe to a strict code of ethics—the first code of ethics, by the way, to be adopted by any trade organization. I am sorry to have to admit that not all brokers follow the ethical tenets of the realtor. I understand that not all surveyors are members of your organization, and that you consider your members the cream of the surveyors, and rightfully so, because your group also has its rules and ethics. Of course, we all agree that the ideal situation would be to have every broker and every surveyor qualified to be a member of our respective organizations. That gives us a goal toward which we should all work.

NEED FOR SURVEYS

Since learning that I was to appear at this meeting, I have done some investigating, and here is what I have found: The realtors of Michigan are recommending a survey of most new construction projects. We realtors, more than any other group, realize the need of a survey, having learned through experience how important such a survey can be in the building of a home.

Let me give you a few illustrations. A bank, in a central Michigan town, negotiated for a loan for a veteran on a GI Bill-of-Rights basis. Some time later, the veteran decided to make a driveway to the rear of this property. The people

next door complained. His land was surveyed, and, to the amazement of all concerned, the veteran's lot was found to be too small to accommodate a driveway. To complicate the situation even more, the neighbor found that his garage was on the veteran's property. There was much delay, an expensive rectifying process, and a great deal of inconvenience suffered by all concerned. This could have been avoided had a survey been ordered before the mortgage was drawn up.

All of you are familiar with the story of the man who purchased his house and decided to paint it, only to find later, by survey, that he did not own sufficient land upon which to set his ladder. Then, there is the case in Wayne County of an HOLC mortgage. A survey showed that the description in the mortgage covered none of the buildings on the property. Oftentimes, buildings have been found to be from a few inches to several feet over another man's property line.

The significant thing about all this is that these instances were brought to light because of complaints by neighbors, or by unusual circumstances, which produced a question as to where the property lines might be. Think of the number of transfers that have been and are being made without anyone questioning them; then think of how many apparently flawless transfers would be found wrong if only someone would question the location of the property lines!

SURVEYORS AND REGISTERED SURVEYORS

This, then, gives rise to the query as to who should make the survey. Is the man qualified, and why is a registered surveyor qualified? I know of cases in which two or more surveyors have established lines from 1 to 9 feet apart.

Now, if I may take the liberty, I would like to make some suggestions.

First, the public must be made to realize the difference between a registered surveyor and just a surveyor—a job for your public relations committee. I asked 10 people to try to explain that difference to me, and only 1 knew the right answer. We have the same problem in real estate; many persons think that every broker is a realtor, but we are gradually correcting that impression.

Second, realtors and loaning institutions frequently have complained to me that the time required to have a survey made is entirely too long for practical purposes. Either we need more registered surveyors, or those already in the business should increase their production.

We, in the selling business, complained to our abstractors about the time it was taking them to obtain abstracts. We explained that the delay caused us to lose business. They promptly agreed to work with us and, as a result, we now get much speedier service in most parts of the State. The same was true with attorneys. I well remember when an attorney would take home an abstract, and he might give his opinion in a week. Sometimes we closed our deals in escrow awaiting his opinion. Now, thanks to many conferences and to a better understanding of our mutual problems, the attorneys realize that the speed of real estate sales has to keep pace with other things in modern living. Today I can take an abstract to a busy attorney, tell him that we need exceptional service in this particular case, and he will render an opinion and prepare the necessary papers for the transfer within 24 hours—frequently, in much less time.

Finally, many loaning institutions and realtors wonder why surveyors have not adopted some comparative standard of prices for surveying. Within the last 2 weeks I have asked in three different central Michigan towns (and I purposely stayed away from Saginaw, my own home city) about prices for survey-

ing a lot in each of those cities. The prices, I find, range from $10 to $35. I believe this variation is too great.

I have not forgotten the admonition that has come down to us through the centuries: "Cast out first the beam out of thine own eye, and then shalt thou see clearly to pull out the mote that is in thy brother's eye." (Luke 6: 42.) We all have faults; but recognition of these faults makes the correction of them much easier.

I am grateful for this opportunity to visit you, and I hope that the registered surveyors and the realtors of Michigan may have many joint meetings in the days to come. Your group has a great future—a tremendous amount of business in the future. We realtors are interested in your growth and we commend you for your past accomplishments.

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A New Approach in Training Programs

IN PROGRAMS NOW USED to train administrators in England and France, discussions and participation by students have replaced lectures, according to Robert Freeman, assistant director of the State Department's Foreign Service Institute, who recently returned from those countries.

In England, the training is given in the Administrative Staff College, a private institution with full Government backing. The college charges small fees and offers a curriculum covering comparative administration, internal organization and management, external relations, and constructive administration. Each quarter during the year, 60 persons nominated by public and private agencies spend 12 weeks at the rural manor where the college is located. Assigned to small groups of 9 and 10, they work with a staff member, elect their own chairman and secretary, and direct their own operations and discussions. Specialists come in not to give lectures but to answer questions. There are no examinations or reports, only evaluations.

In France, Government leaders are trained in the Civil Service Academy established under the DeGaulle regime in 1944. From 50 to 75 participants, drawn from college and technical school graduates and junior executive personnel, are selected by rigorous examination. They spend the first 10 months of training as internees on field assignments and the next year at the Academy in Paris, where they study techniques and procedures and cultural problems. The first quarter of the third year they are assigned to work in private industry. During the following 6 months each student specializes in one of four major fields: general administration, economic and financial administration, social administration, or foreign affairs. The last 3 months are spent under competent supervision in Government work at advanced levels. Participants receive a liberal allowance during training, agree to remain in Government work for a long period, and are eligible for assignment to positions immediately below the top level of National service.—*Newsletter*, Department of Agriculture Graduate School, August 24, 1950.

Shoran—Electronic Tool for Control Surveys and Mapping

By J. L. RANNIE, M.E.I.C.

DOMINION GEODESIST, GEODETIC SURVEY OF CANADA, OTTAWA, CANADA

SHORAN (short-range aerial navigation) triangulation, an adaptation of radar electronic principles, seems likely to provide lengths equal in accuracy to those required for secondary triangulation. Shoran was developed in the United States during the war for use in precision bombing. The military results indicated that it could serve as a tool of far-reaching importance in extending accurate horizontal control quickly over large areas. It could also be used to span areas where visual triangulation methods were impossible, such as for island groups either too far apart or lacking sufficient elevation to overcome the earth's curvature.

EARLY DEVELOPMENT IN CANADA

The application of Shoran to the provision of "control" and to mapping was initiated in Canada late in 1947 as a joint effort by the Royal Canadian Air Force, the National Research Council, the Army Survey Establishment, and the Geodetic Survey. Early in October 1948, experimental work in equipment modification and the training of personnel had advanced to the stage where Shoran measurement of lines joining accurately determined geodetic stations in Ontario and Quebec, situated 200 to 300 miles apart, could be undertaken. This was with a view to obtaining concrete data as to the degree of accuracy that might be expected in a practical survey. The flights were made at intervals throughout the winter over three lines forming a triangle. Close agreement was found between lengths obtained by Shoran and those obtained by geodetic means.

An experimental aerial survey was also made of a small area east of Ottawa with the use of Shoran equipment. During this test the aircraft was directed along the required flight lines by information derived from the Shoran radar equipment. In addition, the data from the Shoran-determined positions of the aircraft were recorded simultaneously with each vertical photograph. The adherence to the flight lines and the correlation between the Shoran and the true positions of each plumb point displayed accuracies beyond expectation.

In conventional geodetic triangulation the angular points are 5 to 50 miles apart and adjacent stations are intervisible; the angles of the triangles are measured with precision theodolites; only a limited number of base lines are measured; and finally, after adjustment of the net, all other lengths are calculated. Shoran, conversely, is a distance measurement system and all lengths are measured; the Shoran stations are from 100 to 350 miles apart, not intervisible; and finally, after adjustment, it is necessary to calculate the angles. In a sense the approach by Shoran is the reverse of ordinary triangulation.

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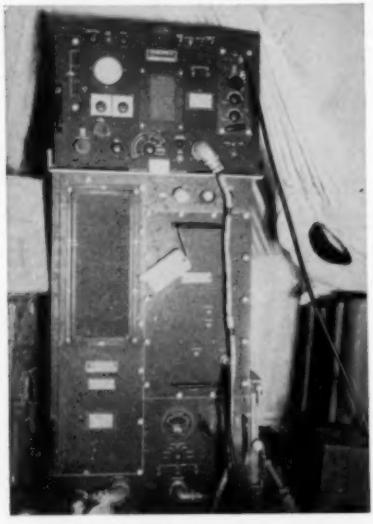
Based on a paper presented by Mr. Rannie before the Surveying and Mapping Division at the joint EIC-ASCE Meeting in Toronto.

Obviously, Shoran can cover a much larger area than conventional triangulation, which makes it especially adapted to such a huge area as northern Canada. Obviously also, the density of the control is much less, but conventional triangulation or other survey methods based on the Shoran net can rectify this disadvantage in sections of the country where more dense control is required.

DIFFERENCES BETWEEN SHORAN AND RADAR

In primary ground-based radar, the electronic apparatus is placed in a suitable location; an electromagnetic pulse is sent out, is reflected from a metal or other surface such as a ship or plane, back to the radar apparatus, and the *time* taken for the pulse to go to and come from the target is measured. This time is automatically converted in the apparatus into *distance* at the speed of light, assuming that the speed of the electromagnetic wave and that of light are equal.

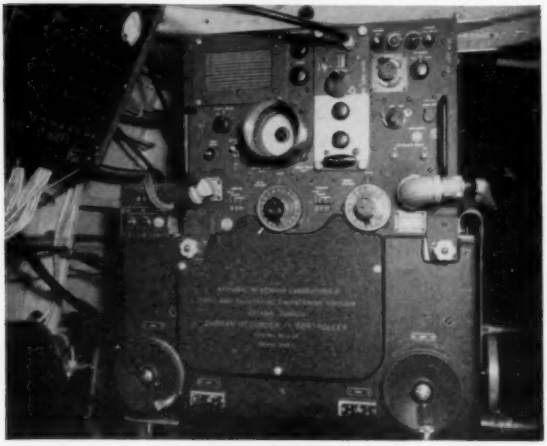


SHORAN TENT-HOUSE GROUND INSTALLATION

In Shoran, the recording apparatus is contained in a plane which flies high over the area concerned. Pulses from the plane on different frequencies are received at two separate ground stations and are automatically transmitted back to the plane. The distances from the plane to the two station locations are then recorded on dials in the Shoran apparatus.

In practice, to secure the distance between two ground triangulation stations, the plane crosses above the midpoint of the line joining the stations nearly at right angles, as indicated in figure 1. When the plane starts its run the sum of the distances to the two ends of the line, termed R and D (rate and drift), is longer than the true distance (the minimum sum). As the plane approaches the line this sum decreases until the line is crossed, then increases. Readings of the dials, as well as the times (every 3 seconds) and other data are recorded on film by a single-exposure movie camera. Four groups (two on each of 2 days) of four flight crossings each (fig. 2), in the form of a figure eight, comprise a minimum program of measurements. On each crossing about 31 readings are used for calculating the minimum $R+D$.

To simplify the explanation of calculating the minimum $R+D$, figure 3 is given. If the readings are plotted on cross-section paper, with the vertical ordinates $R+D$ and the horizontal ordinates times of exposure, it will be found that the curve of best fit is approximately a parabola with its apex down. The $R+D$ ordinate of the apex will be the minimum $R+D$, which is hence the sum of the distances from the plane to the two ground stations when the plane is directly over the line. The equation of the curve of best fit is calculated, and the minimum $R+D$ is calculated from this equation.



AIRBORNE SHORAN INDICATOR AND RECORDER ASSEMBLY IS USED FOR BOTH LINE CROSSING AND MAPPING OPERATIONS. OPERATOR CONTINUOUSLY ADJUSTS TWO CONTROLS TO MAINTAIN PROPER ALIGNMENT OF PIPS ON CATHODE-RAY TUBE. WHEN THIS ALIGNMENT IS ACHIEVED, DIALS INDICATE *D* AND *R* DISTANCES WHICH ARE RECORDED PHOTOGRAPHICALLY.

For very short lines, 20 miles or so in length, the "internal" line-crossing method is not feasible, and an "external" crossing as shown in figure 4 has been experimented with. The crossing is made about 70 miles from the nearer ground station and the values of $R - D$ are calculated, instead of $R + D$ as in the "internal" crossings. This method has many valuable applications if fully successful, since it allows a greater density of control points.

CLOSE MEASUREMENT OF TRANSMISSION TIME

It is startling to realize how minutely the time of transmission must be measured. Since high-frequency electromagnetic waves travel along a line of sight and at approximately the velocity of light, 186,219 miles per second, it follows that to measure a distance to within, say, 25 feet of the truth the Shoran apparatus must be capable of measuring the time of travel from plane to ground and return within 1/40,000,000 of a second. This the present Shoran apparatus can do, and by repetition of the measurements it is quite possible to get a mean value of distance within about 15 feet of the truth. An error of 15 feet in a mile would be intolerably large, but the same error of 15 feet on a 200-mile line is only one part in 70,000, which is high accuracy. In other words, some errors of Shoran are not proportional to the distance, but are just as large over a mile as they are over 100 miles. The proportional error on the long lines is small, however. This indicates why the "internal" method can be used only for the measurement of long lines, say from 100 to 300 miles. It is hoped that this restriction may later be eased considerably when and if "external" line-crossings prove successful.

CORRECTIONS APPLIED

Figure 5 illustrates the minimum R and D values which have been described. Several corrections must be applied to these values and finally these slope distances must be reduced to sea level. A very important correction is that necessitated by the lag or delay in both ground and airborne electronic apparatus, which increases the elapsed time, and hence the measured length of the line. Each set has to be calibrated, and recalibrated from time to time, to determine the delay for that set. This correction may be of the order of -900 feet.

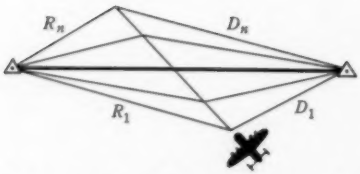


FIGURE 1.—Internal line crossings for Shoran triangulation follow approximate right bisector of straight line between two ground stations.

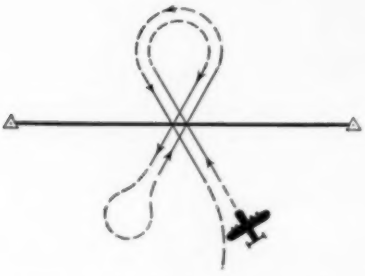


FIGURE 2.—Four-line crossing by plane, in form of figure eight.

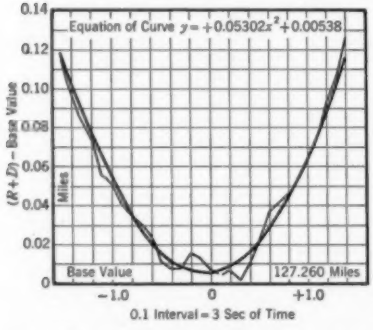


FIGURE 3.—Parabolic curve of $R+D$ readings shows change in recordings as plane approaches, crosses, and leaves straight line between two ground stations.

It will be obvious that variations from standard meteorological conditions—temperature, pressure, and humidity—have an important effect on the recorded lengths R and D, and on the path of the pulse from plane to ground station and return. These variations also affect the altimeter readings in the plane (which vary with meteorological conditions at the same altitude above sea level and may be 100 to 800 feet in error), as well as the assumed value of the velocity of the electromagnetic waves built into the apparatus. Any error in the calculated height of the plane produces an error about one-tenth of its value in the length of the line. This is clearly important.

Since a correct assessment of meteorological conditions is most important, data supplied by the Meteorological Service in the neighborhood is supplemented by readings secured by Shoran ground parties. The ground parties are provided with altimeter, wet- and dry-bulb thermometers, and radio transmitter. These instruments are read every 15 minutes while line-crossing operations are being carried on, and the readings are radioed either to the Shoran plane or to the base. In addition, the Shoran plane, before the line crossings, takes wet- and dry-bulb thermometer readings and indicated air speed at intervals of 1,000 feet from the ground, and up to 1,000 feet above the altitude at which the line crossings are to be made. After the line crossings are completed for the day a descent is made, during which the same meteorological data are collected. From all these data, plus those supplied by the Meteorological Service, the various corrections to the Shoran measurements can be calculated and applied. The method employed was evolved with the cooperation of the Meteorological Service.

The reduction of the field measurements is made immediately after a flight by the geodetic section of the team. As the information accumulates, minor figure adjustments are made. Further indication is also obtained of the relative soundness of the observed values for the lines forming a figure or combination of figures. In a few cases this has revealed the necessity of reflights to maintain accuracy. Table 1 shows the relative size of the various corrections for the line Reindeer to North Spirit.

Each figure-eight flight (fig. 2) gives four values for the length of the line, and present Canadian practice requires 16 crossings, two figure-eight flights on each of 2 days, to secure observations under varying meteorological conditions. If the measurements on the 2 days vary too greatly, reflights are required. The accidental error of the length may be very small but this must not be confused with possible systematic errors which are imperfectly known and against which constant vigilance must be exercised. For example, if the delay correction in a ground set were erroneously determined, there would be a systematic error in the length of all lines radiating from that ground station.

METHOD TESTED OVER LARGE AREA

During 1948 a reconnaissance of an area through Manitoba and central northern Saskatchewan was made, and the scheme of stations and connecting lines shown in figure 6 was selected as a net over which a combination experimental and useful Shoran survey could be made. The net is based upon two geodetic stations, Sprague and Camp Hughes in southern Manitoba, and is to be closed on the two geodetic stations Beatty and Vermilion to the northwest. The axial length of the net is about 1,100 miles, and the longest line to be

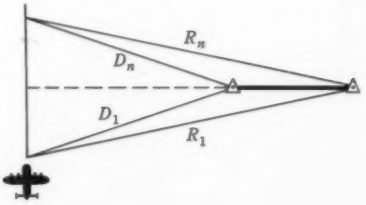


FIGURE 4.—Plan of external line crossing, indicating flight pattern now being tried out to secure high accuracy where lines are shorter than about 100 miles.

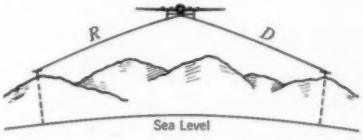


FIGURE 5.—Elevation relation between measured R and D and sea-level distance.

TABLE 1.—*Corrections to Shoran measurements from Reindeer to North Spirit, Canada*

		(*Miles*)
Minimum Shoran distance (uncorrected)		215.2826
Minimum rate station reading		108.2390
Minimum drift station reading		107.0436
	Rate (*Feet*)	*Drift* (*Feet*)
Corrected altitude of plane (H)	18,330	18,330
Antenna altitude at stations (K)	769	1,227
	(*Miles*)	(*Miles*)
Slope distance, R and D	108.2390	107.0436
Delay	−0.1866	−0.1853
Correction to assumed velocity	+0.0056	+0.0056
Frequency correction	−0.0004	−0.0004
Curvature correction	+0.0030	+0.0030
Slope correction	−0.0512	−0.0491
Sea-level correction	−0.0493	−0.0499
	107.9601	106.7675
Reduced Shoran distance	214.7276 miles	

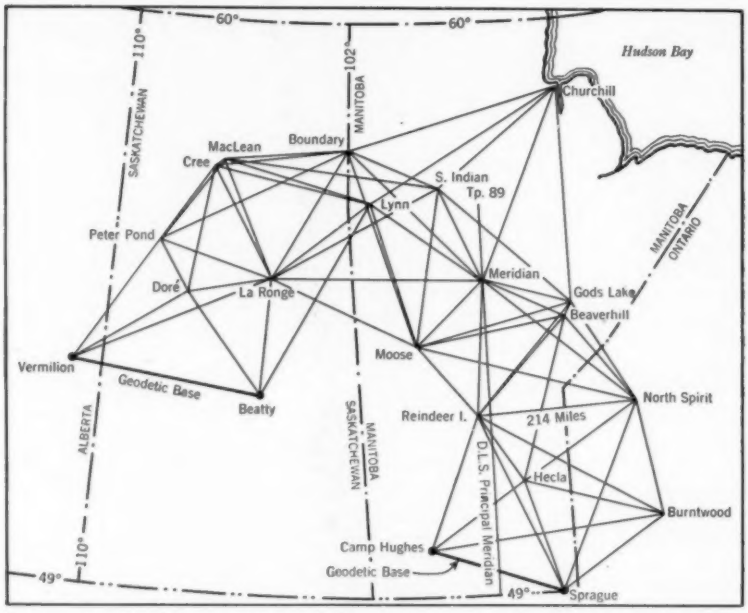


FIGURE 6.—Test Shoran net now being measured in midwestern Canada. Starting from geodetic base line Camp Hughes-Sprague, Shoran net is being extended to close on Vermilion-Beatty, another known geodetic base line.

measured is 310 miles. In contrast with visual triangulation methods, more lines are required to secure accuracy of fixation, since the mathematical conditions to be satisfied are fewer. The selection of lines to be measured has been made to give many right-angle intersections at each station, and two azimuth controls have been introduced, one at God's Lake and one at MacLean. During 1949 the lines inclusive and south of Moose-Meridian-God's Lake were measured. The remainder of the net is expected to be completed in 1950. An assessment of the value of Shoran will be made in the expansion of control over large areas, when it is forced to stand on its own feet. The positions of Beatty and Vermilion will be derived from the Shoran work alone, before the net is finally adjusted to fit the present geodetic coordinates. The discrepancy between the Shoran and the geodetic values of these stations will be a definite answer to the degree of accuracy which can be expected in Shoran control. It is possible to make several adjustments giving misclosures at Beatty-Vermilion, two of which could be for the net with and without azimuth controls.

SHORT-LINE MEASUREMENT HOPED FOR

External line-crossings and azimuth controls are introduced in this net with the hope that short-line measurement will be possible, with corresponding accuracy on long lines, and that the azimuth controls will correct any tendency to deviate from true direction. Both are innovations, and the answer as to their effectiveness should be available

when the net is completed. From the work already completed, it is felt certain that Shoran will give control superior to astronomic fixation. Hence, even before the test net has been completed in 1950, an extension is to be laid out northwesterly toward the Arctic.

Elevations of Shoran stations secured by barometer where checks have been available, indicate that they are correct within 25 feet. Such an error is not serious in Shoran observations. Aneroids, frequently standardized, are read at the station every 3 hours at the times meteorological data for weather maps are secured. These readings are continued for 2 weeks or so, and are then reduced by the Meteorological Service with reference to its weather charts. Naturally, best results are secured where there is the greatest density of meteorological stations, and the results in northern areas may be expected to be less accurate where these stations are sparsely located.

Radar altimetry may eventually be developed to a stage where it will provide suitable elevation data, not only for Shoran purposes, but also for topographic mapping. Its successful use will require traverse and level loop closures to the larger lake surfaces previous to its use in a Shoran area.

Another development which is in the test stage is radio sonde equipment, with a parachute which would be released from the plane while on line crossings. This would provide the needed meteorological data, secured at present by the plane before and after the line crossings.

MAPPING WITH REMOTE SHORAN CONTROL

Where a Shoran net has been laid down it can be used without change for the control of aerial photography over an area devoid of control. As shown in figure 7, ground beacons are set up at two Shoran stations; Shoran equipment is installed in the photographic plane, and radio pulses are sent out continuously from the plane, and at the instant of each camera exposure. The Shoran equipment in the plane records

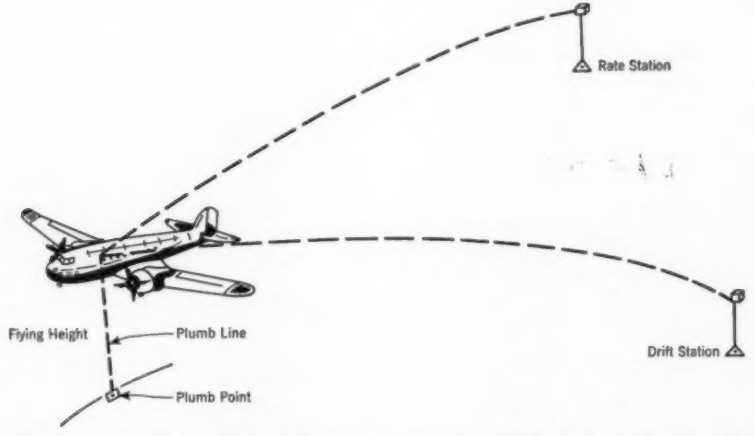
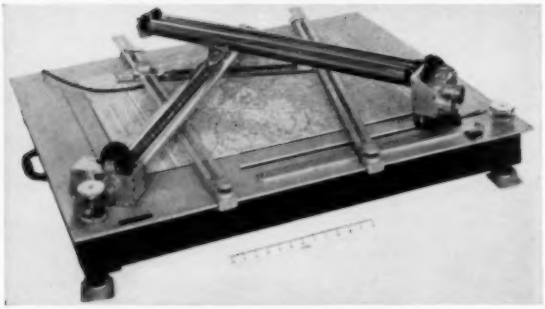


FIGURE 7.—Shoran stations can be used for remote control of aerial photography. Single-exposure cameras are synchronized so as to photograph the ground and the Shoran instrument readings simultaneously.



STRAIGHT-LINE FLIGHT COMPUTER ENABLES PILOT TO DIRECT AIRCRAFT ON STRAIGHT LINE REQUIRED FOR MAPPING FLIGHTS.

the distances to each of the two ground beacons; thus each photograph can be placed in its correct position in latitude and longitude. Tests made in Canada to date have inspired confidence that Shoran-controlled mapping will play an important role in the mapping of northern Canada.

The operator of airborne Shoran radar equipment is required to make continuous adjustments to two controls to maintain proper alignment of the "pips" on a cathode-ray tube. When this alignment is achieved, dials indicate the two distances. The record is obtained photographically by means of a triggered flash, operating with a single-exposure camera incorporated in the same device as the "aided-laying" control systems, through which the operator makes the adjustments. This unit is called the Shoran recorder and is used for both line-crossing and mapping operations.

The aircraft may be directed on the lines required during mapping flights through use of the straight-line flight computer. An adjustment is made for the distance between the two ground stations. As long as the Shoran operator maintains pip alignment, the computer is so driven that the position of the aircraft is located as a point on the map, on which the flight lines are drawn. The deviation of this point from the required flight line is detected electrically, and displayed to the pilot on a meter as track error, enabling the correct track to be made good.

(EDITOR'S NOTE.—The reader's attention is called to a similar investigation conducted in 1946 by the 311th Reconnaissance Wing, U. S. Army Air Forces, and reported in SURVEYING AND MAPPING, Vol. VII, Nos. 1 and 2, pp. 13–15, January–June 1947. Reference should also be made to the extensive Shoran project carried out in the Caribbean area in 1947 by the U. S. Army Air Forces and the subsequent investigation, based on the results of that project, by C. A. Aslakson on the velocity of radio waves, and reported in *Transactions, American Geophysical Union*, Vol. 30, No. 4, August 1949.)

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WHEN President Truman signed the $17,000,000 supplemental appropriations bill, $225,000 became available for the first year's operation of the new National Science Foundation. Originally designed to stimulate research in the more peaceful aspects of science, the Foundation may now find itself concerned with wartime jobs.

One of its jobs will be to keep a roster of the nation's scientific, technical, and engineering personnel. This roster will be invaluable in case of an all-out mobilization. —*Science News Letter*, October 7, 1950.

Federal Surveying and Mapping Agencies

This is the last in the series of sketches on the history, purpose, and scope of activities of federal agencies engaged in surveying and mapping.—EDITOR.

U.S. COAST AND GEODETIC SURVEY

Department of Commerce

HISTORY AND ORGANIZATION

To a maritime nation such as the United States the safety of its waterborne commerce is dependent on a full and complete knowledge of the coast, its nature and form, the character of the sea bottom near it, the locations of reefs, shoals, and other dangers to navigation, the rise and fall of the tides, the direction and strength of currents, and the behavior of the earth's magnetism in areas which must be navigated.

The need for such information was recognized at an early period in the history of the country. Our Nation was concentrated along the Atlantic coastal plain, fisheries and ship-building were important industries, and waterborne commerce between the harbor cities was the medium for the movement and exchange of these and other products. To promote that commerce, Congress passed a resolution on February 10, 1807, authorizing the President to cause a survey to be made of the whole of the coast and harbors of the United States, and of the outlying islands and fishing banks. This was the inception of the Coast and Geodetic Survey.

Recognizing the need for a scientific approach to the work, President Jefferson sought the advice of the American Philosophical Society—the leading scientific body of the period—as to the best method of accomplishing the task. From the various plans submitted, the Society recommended the proposal of Ferdinand Hassler, the founder of the geodetic survey of Switzerland, who was then an instructor in mathematics at West Point.

Work was not undertaken immediately because of lack of facilities and for other reasons. Special types of instruments were required which were not available in this country at the beginning of the nineteenth century, and Hassler was commissioned to go to Europe to purchase some and supervise the design and construction of others. There was further delay due to the War of 1812. A start was finally made with the appointment of Professor Hassler as the first Superintendent of the Survey (this title has in recent years been changed to Director) on June 18, 1816, which is regarded as the date of creation of the Coast and Geodetic Survey.

Founded as the "Survey of the Coast" the Bureau's name was later changed to "Coast Survey" in 1836. In 1871, Congress authorized a geodetic connection to be made between the Atlantic and Pacific coasts in order to provide the States with horizontal and vertical reference markers for the control of their topographic and geologic mapping. As a result of this en-

Prepared in the Office of the Director, U. S. Coast and Geodetic Survey.

larged program, the name "Coast Survey" was changed in 1878 to "Coast and Geodetic Survey."

The Coast and Geodetic Survey is a Bureau of the Department of Commerce with its central office at Washington, D. C. Field offices are maintained at a number of prominent coastal ports and at several cities in the interior so that close contact can be maintained with the needs of commerce and industry.

The present organization of the Bureau consists of both commissioned and civilian personnel. Survey functions are performed for the most part by the commissioned personnel, under the administrative direction of 10 divisions in the Washington Office where analysis and computation of field observations are made and the results compiled in the form of charts, maps, and other publications. The administration of the entire Bureau is under the direction of a Director and an Assistant Director, each holding the rank of Rear Admiral.

PRESENT FUNCTIONS

When the Coast Survey was first organized, the shoreline of our country included only the strip along the Atlantic coast and comprised about 15,000 statute miles. The activities of the Survey grew with the Nation's territorial expansion. The acquisition of new territory along the Pacific coast—later to become the great states of California, Oregon, and Washington—added 8,000 miles to this shoreline before the middle of the century. The purchase of Alaska in 1867 added 34,000 miles. The acquisition of the Territory of Hawaii and of other island possessions, together with the stewardship which we assumed over the Philippine Islands, further increased the shoreline to be surveyed to a total of over 100,000 miles. Bordering this extensive coastline is a belt of nearly 1,000,000 square miles of coastal waters that requires surveys and resurveys in the interest of waterborne commerce and navigation.

The Bureau's functions include a wide variety of essential services for the promotion of commerce, for the development of our natural resources, and for the compilation of certain basic engineering and scientific data. More specifically, the Bureau surveys and charts the coastal regions of the United States and possessions, determines precise geographical positions and elevations in the interior of the country, makes tide and current surveys, and investigates changes in the earth's magnetism.

In recent years, the scope of the Bureau's activities has been enlarged to include earthquake investigations, or seismology, and the preparation and publication of aeronautical charts for civil and military aviation.

AVAILABLE PRODUCTS

An important function of the Coast and Geodetic Survey is the dissemination of its technical information, which is meticulously collected, analyzed, and compiled in the form of charts, maps, and printed publications. Charts and maps and some processed publications are produced in the Bureau's printing plant; other publications are printed at the Government Printing Office. Published material available to the public comprises the following categories:

Nautical charts and Coast Pilots

Aeronautical charts

Planimetric maps compiled from aerial photographs (scales 1:10,000 and 1:20,000)

Geodetic control data (triangulation, leveling, and gravity)

Tide and current publications (Tide Tables, Current Tables, Tidal Current Charts, and special tide and current surveys)

Geomagnetic publications

Earthquake reports

Nautical and aeronautical charts and related publications (Coast Pilots, Tide Tables, Current Tables, Tidal Current Charts) can be purchased at its Washington Office, at field offices, and from authorized sales agencies of the Bureau. Copies of field surveys, planimetric maps, triangulation and leveling data, bench mark data, and information on temperature and density of sea water are also obtainable from the Washington Office. Manuals and special publications are obtainable on a sales basis from the Superintendent of Documents, Government Printing Office, Washington, D. C.

HYDROGRAPHIC SURVEYS

Hydrographic surveys, which determine the depths of water and their locations, form the basis for the nautical charts published by the Bureau. During the century and a quarter that the Coast and Geodetic Survey has been engaged in charting the coastal waters many changes have taken place in the methods and equipment used in hydrographic surveying, each change resulting in an accumulation of more accurate and more detailed information for the navigator's use.

The most significant of these advances occurred during the periods following World War I and World War II. The measurement of ocean depths with handlead and wire gave way to measurement by echo sounding. For fixing the positions of the soundings a method known as Radio Acoustic Ranging was developed which utilized sound and radio to determine the distance of the survey ship from known shore stations.

World War II ushered in the electronic era in hydrographic surveying. The techniques of Shoran, used during the war for strategic aerial bombing, were adapted by the Bureau to the accurate location of a survey ship at distances as far as 50 to 75 miles from shore. This method is being used successfully along the Atlantic coast and in Alaskan waters. To overcome the line-of-sight limitations of the Shoran method, a new equipment, known as the Electronic Position Indicator, was developed which permits the extension of accurate hydrographic surveys as far as 300 miles from shore. This system is particularly useful for surveying in the Gulf of Mexico where the low coastline places a practical limitation on the elevation of the electronic control stations on shore.

DETERMINING A SURVEY VESSEL'S POSITION BY SHORAN

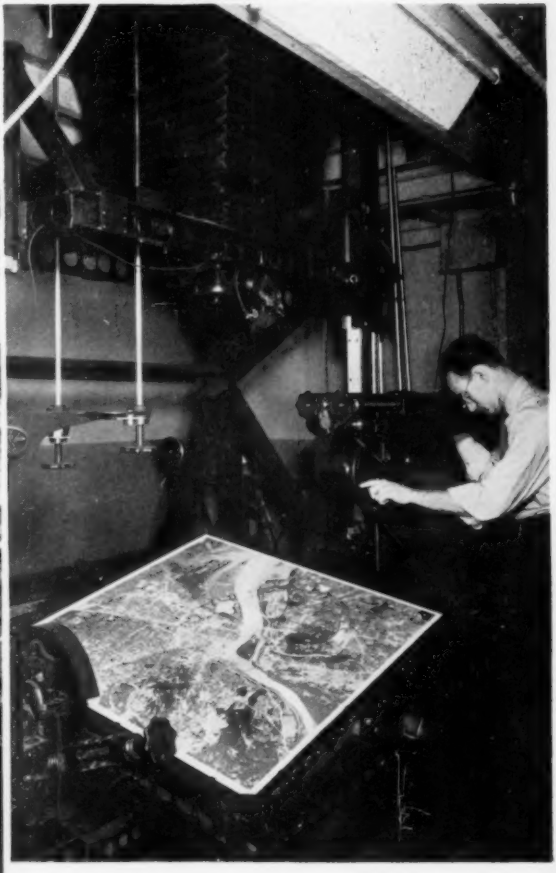
The application of these scientific principles has resulted in a new concept of accuracy as applied to offshore hydrographic surveying. The ocean bottom has been investigated to the limits of the Continental Shelf and Slope and many new and amazing facts have been discovered. The submarine features along the coasts have been charted and have proved of much value to the navigator equipped to determine his position by echo sounding.

GEODETIC CONTROL SURVEYS

As its name indicates, the Coast and Geodetic Survey is the Bureau of the Federal Government which makes the geodetic control surveys. It was recognized at an early period in the history of the Survey that an undertaking

NINE-LENS AERIAL CAMERA

RECTIFYING CAMERA FOR REMOVING TILT FROM NINE-LENS PHOTOGRAPHS



← A NINE-LENS COMPOSITE AERIAL PHOTOGRAPH OF A GLACIER AREA IN SOUTHEAST ALASKA. NOTE THE CENTER AND WING PICTURES.

of such vast magnitude could not be attacked as a problem in ordinary surveying, but must be accomplished by methods which take into account the shape and size of the earth. This is the province of geodetic surveying and includes the measurement of base lines, astronomic observations, triangulation and traverse work, precise leveling, and measurement of the force and direction of gravity.

Originally the geodetic surveys in this country were made for the control of surveys of the coasts and to provide a proper tie for the nautical charts of the coastal waters. By the act of 1871 these activities were expanded to make a geodetic connection between the Atlantic, Gulf, and Pacific coasts. Since that time, the Bureau has been actively engaged in extending triangulation and precise levels in the interior of the country for the purpose of establishing a Federal framework on which all land surveys and engineering projects could be based.

To span the continent from coast to coast and from north to south, widely spaced arcs of triangulation were first established. This gave a preliminary framework. Intermediate arcs, spaced 40 to 60 miles apart, provided control for boundary determinations and general purposes of the various States. The next logical step has been followed in the last decade and work has begun on filling in the areas between these arcs with "area" triangulation.

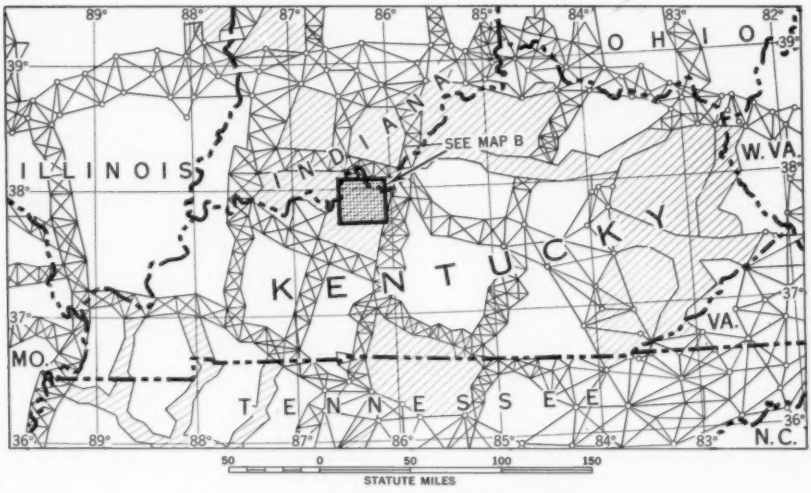
At least one triangulation station is being established in each 7½-minute topographic quadrangle, with stations at 4-mile intervals along the main highways in agricultural areas and closer spacing in metropolitan areas. To coordinate local urban surveys, at least one Federal base is being established in metropolitan areas of 100,000 population or over.

There are now more than 100,000 miles of arcs of first- and second-order triangulation in the United States, with monumented stations established at intervals along the various arcs. Geographic positions (that is, latitude and longitude) have been determined for about 150,000 points consisting of monumented stations, and prominent objects, such as water tanks, church spires, cupolas, chimneys, etc. To facilitate the engineer's and surveyor's use of the national network, a nearby azimuth mark, visible from the station, is established at each monumented point.

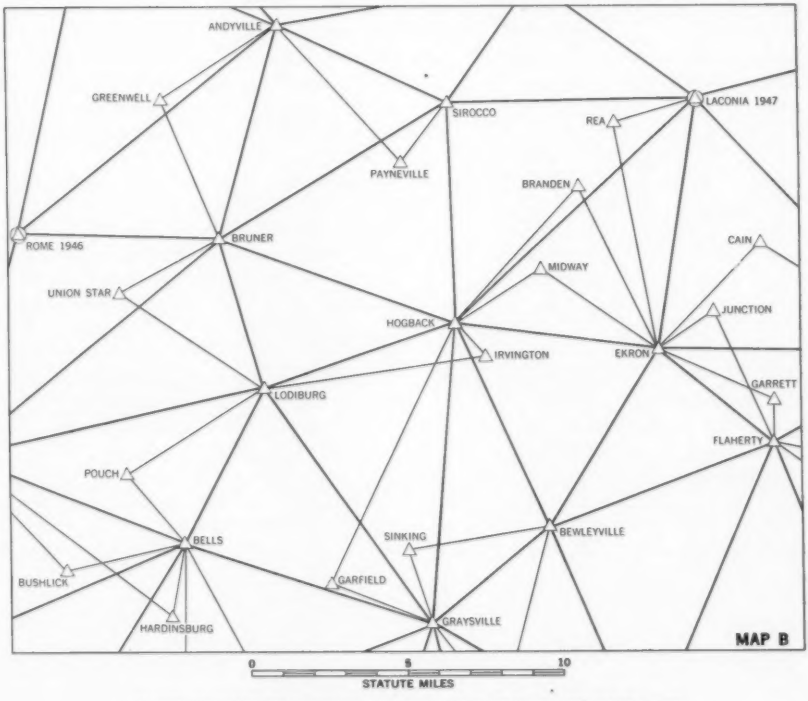
In the distribution of the vertical control of the country a similar pattern was followed. Widely spaced lines, 100 miles apart, were first established, and were later supplemented by lines at 50-mile intervals. At the present time, "area" leveling is being provided, with lines spaced 6 miles apart connected to the wider spaced lines in a consistent network of levels. Bench marks are set at 1-mile intervals along each line. For convenience in running and in the subsequent use of bench marks, the lines of leveling usually follow the routes of highways and railroads. There are now more than 370,000 miles of first- and second-order leveling in the United States and upward of 275,000 established bench marks.

While great strides have been made in providing these basic data for the country, the job is far from complete. The Bureau's concept of adequacy is continually changing, as it necessarily must, to meet the ever-widening needs of commerce and industry. It is the present policy to increase the number of monumented stations to provide for area coverage of triangulation and levels, the intensity depending upon the needs of agricultural, urban, and industrial regions.

Improved instruments and equipment have accelerated the progress of triangulation. Hassler had a special carriage built to transport his cumber-



PORTION OF TRIANGULATION NET OF UNITED STATES



"AREA" TRIANGULATION IS USED TO FILL GAPS BETWEEN MAIN ARCS

some 24-inch theodolite, and it took four men to haul it to a station; theodolites used today in first-order work have a 9-inch circle and can be backpacked up mountain slopes by one man.

One device which has speeded up progress and intensification of geodetic work is the portable steel tower, designed to overcome interference in vision due to curvature of the earth or forest growth.

STATE PLANE COORDINATES

The results of the triangulation of the Coast and Geodetic Survey are expressed in terms of geographic coordinates. Such coordinates are most convenient where extensive areas are involved. They constitute a universal system, all points of which are directly related. The Bureau has recognized, however, that engineers and surveyors, unfamiliar with the computational methods involved, hesitate to use geographic coordinates for surveys of smaller areas, such as those performed within a State, county, or city. Considering the desirability of having all surveys tied into the Federal network of geodetic control, the Coast Survey in 1933 devised a system of plane coordinates for each State and developed the formulas for the transformation of geographic coordinates to their corresponding X and Y values. By these systems, points on the earth's surface are mathematically projected upon a developable surface. Surveys between such points can then be treated as though the work were accomplished on a plane instead of a spheroidal surface.

In the practical field use of State Coordinates, the engineer needs only the plane coordinates of the triangulation stations and the plane azimuth to an azimuth mark within the area covered by his survey. These data are sufficient for him to run and adjust his traverse, using the ordinary methods of plane surveying, and obtain an accuracy of not less than 1 part in 10,000. If greater refinement is required, the computations may be brought to geodetic accuracy by applying corrections for scale error.

SURVEYS IN ALASKA

Surveys in Alaska were begun by the Bureau soon after the purchase of that territory from Russia in 1867. The coastal area and its newest waterways were known only to a few explorers and trading vessels. Its vast interior was almost completely unknown.

The first surveys were exploratory in nature. Detached coastal surveys were made in many widely separated areas and navigational charts were published to facilitate the commercial and industrial development of the territory. With the beginning of the twentieth century the Coast and Geodetic Survey inaugurated a comprehensive program of surveys which has been fairly continuous ever since. In recent years, systematic surveys have been undertaken in the Aleutian Islands area and in the Bering Sea area, and along the Arctic coast.

Contemporaneously with the survey of the coastal waters, a network of geodetic control was established along the coasts and in the interior. Alaska is now tied to continental United States on the same geodetic datum (the North American 1927 datum) by continuous arcs of triangulation that extend from Puget Sound through southeast Alaska and through the heart of Alaska to the Little Diomede Island in Bering Strait, with a spur along the Alaska Peninsula and through the Aleutian Islands. This is a notable achievement for mapping and an important factor in the establishment and charting of widely separated electronic master stations for long-range sea and air navigation.

Triangulation surveys are now in progress in western Alaska and along the Arctic coast. Trigonometric level-

MEASURING ARCTIC DEPTHS UNDER DIFFICULTIES

A SURVEY CAMP IN THE ARCTIC

ing will be carried on concurrently, and elevations and positions will be determined for the numerous peaks in the extensive mountain ranges of northern Alaska.

Topographic surveys in Alaska are accomplished by photogrammetric methods using a nine-lens aerial camera and associated plotting equipment. Nine-lens mapping is peculiarly adapted to the rugged terrain of the country where the establishment of adequate control is an expensive undertaking. Because the coverage of a nine-lens photograph is 16 times greater than the area covered by a single-lens photograph, only one-fourth the number of control stations is required.

BASE MEASUREMENT ON THE ICE

A SURVEY PARTY'S BEST FRIEND IN THE FROZEN NORTH

The ultimate goal of Alaska surveying, insofar as the Coast and Geodetic Survey is concerned, is a complete delineation of its 34,000 miles of tidal shoreline together with the adjacent coastal topography; a complete hydrographic survey of the surrounding waters from the coastline to the limits of the Continental Slope, including wire dragging of critical areas to insure the safety of naval and merchant vessels; comprehensive tide and current surveys of the principal passages and of other areas; magnetic observations and the collection of seismologic data; and the establishment of a geodetic network in the interior on which large-scale mapping can be based. As survey operations move farther into the northern latitudes new problems and new difficulties will face the hydrographic and geodetic engineers. This is particularly true of the Arctic region, and in portions of the interior, where the problems of supply and transportation coupled with low temperatures will be a challenge to the ingenuity and endurance of the personnel.

NAUTICAL CHARTS

One of the principal products of the Coast Survey—the one for which it was originally established—is the nautical chart, which guides the mariner over what is often termed the trackless sea. It shows him the hidden dangers and the safe lanes and opens our ports to the armadas of commerce. When General MacArthur began his reconquest of the Philippine Islands on the 20th of October 1944, he had with him navigational charts of the area in which landings were to be made. These charts were made by the Coast and Geodetic Survey from surveys carried on during the 40 years of the United States stewardship of the islands. They showed the character of the beaches, the safe channels, and the locations of dangers to navigation; and gave information on the rise and fall of the tide—all of which enabled the ships and landing parties to maneuver with a minimum of hazard.

Nautical charts are compiled principally from the basic field surveys of the Bureau, supplemented by data from other government organizations. They include all available information necessary for safe navigation.

To meet the different navigational needs, upward of 900 nautical charts are published in different series, classified as Sailing, General, Coast, and Harbor. A vessel sailing between two distant ports requires a different type of chart from that needed for approaching a coast or entering a harbor. Chart scales range from 1:2,500, the largest-scale harbor chart, to 1:5,000,000, the smallest-scale sailing chart. For the Atlantic and Gulf coasts the 1:80,000 scale series (approximately 1 inch = 1 nautical mile) gives the largest continuous coverage, while on the Pacific coast it is the 1:200,000 scale series (approximately 1 inch = 3 nautical miles). A special series of 1:40,000 scale charts (approximately 1 inch = $\frac{1}{2}$ nautical mile) covers the Atlantic Intracoastal Waterway between New York and Key West and a similar series covers the Gulf Intercoastal Waterway.

Nautical charts, with few exceptions, are constructed on the Mercator projection.

AERONAUTICAL CHARTS

The Bureau's service to aviation is of relatively recent origin. The aeronautical charting program was initiated 25 years ago under authority of the Air Commerce Act of 1926. The Bureau compiles and prints aeronautical charts of the United States and possessions for civil and military aviation and also for international airways that are required primarily by United States civil aviation.

The first complete chart coverage of the terrain of the United States on a uniform scale was provided by the Sectional Chart series published by the Bureau in 1935 at a scale of 1:500,000 (approximately 1 inch = 8 statute miles). This is still the basic series for the United States and contains a wealth of topographic information useful for many purposes. A second series covering the United States and Alaska is constructed at a scale of 1:1,000,000 (approximately 1 inch = 16 statute miles) and is part of a World Aeronautical Charts series. Both series are constructed on the Lambert conformal conic projection.

Other series of aeronautical charts published at different scales are designed to meet the special needs of aviation. Among these are Instrument Approach and Landing, Direction Finding, Route, Local, Radio Facility, and Aircraft Position charts.

Aeronautical charts are compiled from the basic surveys of the Bureau, supplemented by the best topographic data from more than 50 miscellaneous sources. They are designed to be read

easily by the aircraft pilot and emphasis is placed on features of aeronautical importance. Vertical relief on many of these charts is shown by contours and a system of gradient tints. Airports, beacon lights, radio-range stations, and other aeronautical data are overprinted in color.

Close liaison is maintained with the Civil Aeronautics Administration and with the Air Coordinating Committee to keep the Bureau's charting program abreast of developments in air navigational facilities and techniques.

TIDE AND CURRENT SURVEYS

A knowledge of tides and tidal currents is essential to every maritime nation. The hydrographic engineer must know the height of the tide at each instant during his survey so that the nautical chart will show all depths referred to a uniform datum. Modern deep-draft vessels operating on fixed schedules must have advance information on the rise and fall of the tide and the ebb and flow of the current as a prerequisite to safe navigation.

OBSERVING TIDES WITH A PORTABLE GAGE

The Coast and Geodetic Survey is the Federal agency charged with the study and investigation of the tides. Measurements of tides and currents are made at numerous stations along the coasts and furnish information for the preparation of tide and current tables which are published annually in advance. From these and the nautical chart, the navigator determines the exact depth of water available at a given time and place and the direction and strength of the current.

GEOMAGNETIC SURVEYS

The magnetic work of the Bureau is planned to meet the needs of the navigator and the land surveyor. The magnetic compass is still a basic instrument for marine and air navigation; small vessels depend on it and large ships use it for checking the correct operation of the gyrocompass. Airplanes use the compass in conjunction with other forms of direction indicators. For the land surveyor a knowledge of the change in magnetic declination is necessary in the retracement of old boundaries, many of which were defined in deeds by compass bearings.

Magnetic declination varies from place to place and from day to day, and even during the course of a day, due to the constantly changing direction and strength of the magnetic forces of the earth. The comprehensive magnetic survey of the United States, which the Coast Survey is conducting, provides the information for the study of these changes. Magnetic observations have been made at several thousand places, and repeat observations are made at 5-year intervals at approximately 200 selected stations. Continuous photographic records of changes in the prin-

cipal magnetic elements are also obtained at seven magnetic observatories located in the United States, Alaska, the Hawaiian Islands, and Puerto Rico.

EARTHQUAKE INVESTIGATION

Some 25 years ago the Federal Government began to take an active interest in the economic and social aspects of the earthquake problem. The importance of a solution to the country as a whole became apparent and the Coast and Geodetic Survey, because of its long experience in the operation of delicate recording instruments and in the interpretation of records, was assigned the job of carrying on the necessary investigations.

The program of the Bureau is planned to locate the points of origin of all significant earthquakes in the United States and its possessions, to map earthquake areas, to determine the destructive effects as well as the nature of earthquake motions, and to safeguard life and property by furnishing the engineer with data for use in designing structures better able to withstand earthquake shocks.

CONTRIBUTIONS TO THE NATIONAL WELFARE

Throughout its long history the Coast and Geodetic Survey has provided leadership in the various fields of its activities. It has contributed to the national welfare through its service to commerce, industry, and science. Its accumulated data together with its technical procedures—embodied in numerous reports, manuals, and special publications—constitute a vast reservoir of precise facts of immediate and potential value to the engineer, surveyor, and scientist. And because of its unique organization, its technically trained personnel, and its specialized equipment, the Bureau forms an effective reserve for service to the country in times of national emergency.

U. S. COAST AND GEODETIC SURVEY SHIP *PIONEER*

ONE OF A FLEET OF VESSELS USED IN SURVEYING THE COASTAL WATERS OF THE UNITED STATES AND ALASKA. THE VESSEL IS EQUIPPED WITH THE MOST MODERN ELECTRONIC SURVEYING AND NAVIGATING INSTRUMENTS.

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

ALASKA. L. Dudley Stamp, *The Journal of the Manchester Geographical Society*, Vol. LIV, 1947–49. (Provides historical, geographical, economic, and ethnographic data on Alaska.)

PRINTING. *Fortune*, October 1949. (A graphic portfolio of the techniques of multicolored reproduction, including present developments and possibilities for the future.)

COASTAL DELINEATION FROM AERIAL PHOTOGRAPHS. P. G. McCurdy, *The Canadian Surveyor*. Special Edition. Proceedings of the Forty-Third Annual Meeting of the Canadian Institute of Surveying and Photogrammetry, February 1 and 2, 1950. (Discusses the major problems involved in coastal delineation.)

SHORAN APPLICATION TO MAPPING. Major J. I. Thompson, *The Canadian Surveyor*, April 1950. (Discusses experiments made in Canada to test the characteristics, requirements, and approaches necessary to make full use of Shoran for mapping.)

SHORAN NAVIGATIONAL TECHNIQUES. R. A. Nordman, *The Canadian Surveyor*, April 1950. (Canada's study of navigational techniques as applied to Shoran flying is described.)

CHEAP, FAST GROUND CONTROL. Joseph G. Kelley, *Engineering News-Record*, April 13, 1950. (Compares the trig-traverse method, a modification of the subtense principle, with ordinary third-order traverse or triangulation.)

IS THE ATLANTIC COAST SINKING? THE EVIDENCE FROM THE TIDE. H. A. Marmer, *The International Hydrographic Review*, May 1950. (Raises the question of whether there is some actual subsidence of the coast or an actual rise of sea level, or both.)

THE NAUTICAL MILE. Alton B. Moody, *The International Hydrographic Review*, May 1950. (Defines the nautical mile; relates where it originated and when it was first used.)

LAND SURVEYORS' EXAMINATION (AUSTRALIA AND NEW ZEALAND). *The Australian Surveyor*, March–June 1950. (Reprint of an examination given for land surveyors.)

SECOND-ORDER AND MINOR TRIANGULATION. L. N. Fletcher, *The Australian Surveyor*, March–June 1950. (A comprehensive discussion of field and office procedure followed in Australia for triangulation surveys.)

LAKE SURVEY—CURRENT FIELD OPERATIONS. *The Military Engineer* (Surveys and Maps), May-June 1950. (Describes the United States Lake Survey's accomplishments on the Great Lakes during 1949.)

A SURVEY OF GEOPHYSICS. Friedrich Gassmann, *The Scientific Monthly,* June 1950. (Presents physics broken down into five sections: the solid earth as a whole, the outermost shell, the earth's crust, the subsoil, and the soil.)

A WORLD LAND USE SURVEY. *The Geographical Journal,* June 1950. (This report by the Commission established by the International Geographical Congress held at Lisbon in 1949 covers accomplishments to date in initiating a world-wide survey or inventory of land use.)

SHIPS SEEK DEEPEST OF THE DEEPS. *All Hands,* July 1950. (Describes the search being made to find the deepest water in the world.)

SURVEY FOR COLONIAL DEVELOPMENT. M. Hotine, *Empire Survey Review,* July 1950. (Describes how Colonial development is essential to the prosperity of Britain and how the land surveyor is essential to economic development.)

GEOLOGICAL SURVEY—THE NATIONAL MAPPING PROGRAM. *The Military Engineer* (Surveys and Maps), July–August 1950. (Describes current mapping operations of the Geological Survey.)

GEOLOGY. Reginald A. Daly, *Scientific American,* September 1950. (Discusses how the search for the major geological features has advanced further into the depths of the earth and time.)

THE USE OF AERIAL PHOTOGRAPHY IN SEAWEED SURVEYS. H. L. Cameron, *Photogrammetric Engineering,* September 1950. (Describes experiments by the Nova Scotia Research Foundation in testing the feasibility of vertical aerial photography for seaweed and bottom detail surveys.)

A LIST OF ARTICLES ON MAPS. *The Journal of Geography,* October 1950. (Annotated bibliography covering map articles published over a period of 28 years in *The Journal of Geography.*)

MUNCH-PETERSEN'S LITTORAL DRIFT FORMULA. *Bulletin of The Beach Erosion Board,* October 1950. (Translation of speech by Sv. Svendsen in Helsingfors based on theory of Professor Munch-Petersen concerning material drift along the ocean coasts; no previously published English translation of this treatment.)

BOOKS AND PAMPHLETS

ATLAS DE CUBA. Gerado Canet, in collaboration with Erwin Raisz. *Harvard University Press,* Cambridge, Mass. 1949. 63 pages. (Describes the geographic and social backgrounds of the republic.)

A DICTIONARY OF GEOGRAPHY. Definitions and Terms Used in Physical Geography. W. G. Moore. *Harmondsworth,* Middlesex, England. 1949. 182 pages, illustrations. $0.35. (Contains about 1200 terms and covers the entire field of physical geography, particularly geomorphology, biogeography, meteorology, climatology, and oceanography.)

GEODETIC PROBLEMS IN SHORAN. J. E. R. Ross. *Controller of Stationery,* Ottawa, Canada. 1949. 90 pages. $2.00. (Discusses the computation of radar triangulation networks.)

ABC'S OF PHOTOGRAMMETRY (Parts I and II). Gomer T. McNeil and Ralph O. Anderson. *Edwards Bros.,* Ann Arbor, Mich. 1950. 160 pages. $3.00 each. (Part I deals with elementary photogrammetry. Part II tells how to determine the tilt, swing, flying heights, ground distances, and elevations of aerial photographs.)

APPLIED GEOLOGY (Volume 45, Number 1B). Department of Publications, *Colorado School of Mines,* Golden, Colo. 1950. 343 pages, 81 illustrations, tables, and maps. $3.00. (Contains papers presented at conferences on geology.)

CANADA. Edited by George W. Brown. *University of California Press,* Berkeley 4, Calif. 1950. 621 pages. Maps and illustrations. (Tenth single-country handbook in the United Nations series. Serves as a useful reference work on Canada and its place in the modern world.)

ENGINEERING SURVEYS: ELEMENTARY AND APPLIED. Harry Rubey, George E. Lommel, and Marion W. Todd. *The Macmillan Co.,* New York. 1950. 169 pages. $5.00.

EXTREME AND MEAN ALTITUDES IN THE UNITED STATES, ITS TERRITORIES AND POSSESSIONS. *U.S. Geological Survey,* Department of the Interior, Washington 25, D. C. 1950. (Revised edition of circular available without charge from Map Information Office, USGS.)

A GEOGRAPHY OF EUROPE. Jean Gottmann. *Henry Holt and Company,* New York. 1950. $5.00. (Many well-selected maps and photographs present the relationship of postwar cultural and economic activities to the topography of Europe.)

GEOLOGY AND MINERAL DEPOSITS OF AN AREA NORTH OF SAN FRANCISCO BAY, CALIFORNIA. (With Box of Maps, Plates 1 through 20.) Charles E. Weaver. *Department of Natural Resources,* California. 1950. $4.00. (The geography, systematic geology, structure, and economic deposits of an area of approximately 2,215 square miles are discussed in this report.)

MAPS OF ALASKA. Map Information Office, *U.S. Geological Survey,* Washington 25, D. C. 1950. 4 pages. (Brief description of various types of maps and charts of Alaska published by Federal agencies. Pamphlet may be obtained free from publisher.)

MARINE GEOLOGY. P. H. Kuenen. *John Wiley & Sons, Inc.,* New York. 1950. 568 pages, 250 illustrations. $7.50. (Summarizes present knowledge concerning submarine landforms and their interpretation, sedimentary cover of the sea floor, and other factors contributing to the study of marine environment.)

PLANE SURVEYING. Frank R. Theroux and Lisle A. Smith. *Pitman Publishing Corp.,* New York. 1950. 338 pages. $3.50. (Stresses the practical side of surveying. Contains sets of problems; tables of stadia coefficients; logarithms of numbers; and logarithms of sines, cosines, tangents, and cotangents.)

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THE STAR ALMANAC FOR LAND SURVEYORS FOR THE YEAR 1951. H. M. Nautical Almanac Office, *H. M. Stationery Office,* London. 1950. 66 pages. 3s.

TOWARD THE POLES. James Edward Cohn. *Department of the Navy,* Washington 25, D. C. 1950. 230 pages. (An historical sketch of the Navy's operations in the Arctic and Antarctic regions.)

USES OF AERIAL SURVEYS. *Aero Service Corp.,* 236 E. Courtland St., Philadelphia, Pa. 1950. 24 pages. (Describes typical uses and advantages of aerial surveys. Copies are distributed free upon request.)

ZEITSCHRIFT FUR VERMESSUNGSWESEN. (German Journal of Surveying.) January 1950. (The first issue of this publication.)

—A. A. STANLEY

DISTINCTIVE RECENT MAPS

In commemoration of the 150th birthday of the Nation's Capital City, the Coast and Geodetic Survey has reprinted a six-color reproduction of the original 1791 *L'Enfant Plan* of Washington, D. C. The original manuscript plan was restored and reproduced by the Coast and Geodetic Survey in 1887. Copies of this edition have long been out of print.

The new reprint is on a large sheet of paper measuring 30 by 47 inches. Copies are available from the Coast and Geodetic Survey at 50 cents each.

The Soil Conservation Service, U. S. Department of Agriculture, has published several interesting new maps in recent months. *Conservation Districts Having Irrigation* shows the districts which are being assisted by the Soil Conservation Service. A marginal table gives a breakdown in acres by regions and states for the western part of the country. The measurements of the map are 11½ by 17 inches. No scale is indicated.

The northeastern part of the United States is covered by a *Principal Drainage Map* and a *Land Resource Unit Map,* both published in 1949. They are on the scale of 1:500,000 and measure 16½ by 17¾ inches. Major, secondary, tertiary, and minor area boundaries are indicated on the former map. The *Land Resource Unit Map* outlines boundaries of physiographic regions, problem areas, land-resource units, public-owned lands, and metropolitan and industrial areas.

Soil Conservation Service Operations are shown for Conservation Region Five (northern Great Plains) on three maps published in March 1950. Each measures 16¾ by 20½ inches and is drawn to the scale of 1:3,500,000. One map shows only state and county boundaries and the drainage pattern. The second spots headquarters for work units, work groups and regional offices, and shows work groups, soil conservation districts, cooperative state grazing districts, land utilization projects, and the Wheeler-Case Irrigation Project. The third map (on verso of second map described) has county and state boundaries, drainage network and boundaries, and numbers of soil conservation zones.

Present and Proposed Irrigation in the Missouri River Basin is shown on another Soil Conservation Service Map. Reservoirs, irrigated and irrigable land, and systems of levees are indicated. The map measures 9½ by 12⅞ inches. No scale is given.

Generalized *Classification of Land According to its Capability for Use in the State of Washington* is shown on a colorful map published by the Soil Conservation Service in 1949. The scale is 1:750,000 and the measurements 24 by 32¾ inches. All the land is divided into eight broad classes. The first four classes include land which can be plowed and cultivated safely without lasting damage; the land classified by the remaining four is not suited for cultivation.

Essential United States Foreign Trade Routes is a recent map (May 1949) published by the Bureau of Government Aids, U. S. Maritime Commission. It shows 31 trade routes on a Mercator world map measuring 20½ by 34 inches. No scale is given.

The U. S. Geological Survey has recently published several additional sheets in its series of topographic maps with shaded relief. The lights and shadow effect produced by skillful use of the air brush creates the illusion of actual heights and slopes on these maps. The shaded relief on the topographic maps adds to their value for teaching purposes and makes the physical features more apparent to the layman.

The *Waldron, Arkansas Quadrangle* (scale 1:62,500) portrays the characteristic relief features of folded mountains, (Ouachita Mts.), which have been subjected to erosion. Asymmetric hills flank plunging synclines and anticlines. There are a number of "water gaps" where streams have cut through hard-rock ridges. A "trellis" drainage pattern typical of such folded mountains is also readily identified.

Folded mountain topography at the northern end of the Shenandoah Valley is shown

on the *Strasburg, Virginia Quadrangle,* another in the special series of shaded relief maps. It includes the north and south forks of the Shenandoah River separated by the long parallel ridges of Massanutten, Green, Three Top, and Powell Mountains. Parts of George Washington National Forest are shown on the central and northwest portions of the map. A corner of Shenandoah National Park, including part of the Blue Ridge Mountains, appears in the southeastern section. In addition to the physiographic and geologic interest, the area has historical importance as the site of several Civil War campaigns. The scale of the Strasburg Quadrangle is 1 : 62,500.

The shaded relief map of *Denver Mountain Area* is scaled at 1 inch to 3 miles and covers approximately 5,700 square miles on a large sheet (30 by 23½ inches). The cities of Denver, Boulder, Central City, Idaho Springs, and Fort Collins are included. The relief shading, printed over 500-foot contours, emphasizes the mountainous portion of the region. The Continental Divide can be traced to the left of the map's center. Other interesting features shown include the Colorado-Big Thompson water diversion project, and the extensive irrigated farm area in the plateau region in the eastern part of the map. The verso of the map has detailed descriptive information on the *Denver Mountain Area* including its setting, geologic history, series of sketches illustrating how the mountains were formed, and the effects of the Ice Age in Colorado.

Several additional sections of Alaska are also shown on new shaded relief maps. They include the *Talkeetna Mountains* and *St. Lawrence* sheets, both on the scale of 1 : 250,000. The Talkeetna Mountains sheet maps an area of about 6,654 square miles located north of Anchorage and southeast of Mt. McKinley. It is a rugged mountain region, completely wild and unsettled. Small glaciers and snow fields cover the higher crests and glacial lakes occupy some of the mountain summits, hillsides, and passes. The Susitna and Talkeetna Rivers, flowing generally westward, drain the area with their numerous tributaries.

The St. Lawrence sheet shows St. Lawrence Island in the Bering Sea. There are no contour lines on this map and topography is indicated by shaded relief only. Poovookpak and Kookoolgit Mountains comprise the core of the western part of the island. The smaller peaks of My-Ghapawit and Kinnipaghulghat Mountains rise near the eastern end. The lowlands between the mountains are dotted with lakes. A number of erosional and depositional shoreline features are seen along the coasts.

The Republic of Colombia is portrayed in generalized relief on the *Mapa de la Republica de Colombiá* published in 1950 by el Instituto Geografico Militar y Catastral. The map is on the scale of 1 : 2,500,000 and measures 30 by 22 inches. In addition to the hypsometric color gradations, the map shows international, departmental, and municipal boundaries; several classes of roads, and railroads; and towns and villages. This preliminary edition is edited and distributed for El Banco de la Republica.

Lines of Equal Magnetic Declination and Annual Change in the Northwest Territories and Yukon for 1948 is the title of a new isogonic map of the northern part of North America. The lines are superimposed on the 1 : 5,068,800 base map of the Northwest Territories and Yukon prepared by the Surveys and Mapping Bureau of the Canadian Department of Mines and Resources. Magnetic data was supplied ". . . by the Division of Terrestrial Magnetism, Dominion Observatory, from measurements made at stations distributed throughout the area from 1943 to 1948, inclusive, by officers of Dominion Observatory, the Surveys and Mapping Bureau, the United States Coast and Geodetic Survey and the Carnegie Institution of Washington." The North Magnetic Pole is located on the east shore of Ommanney Bay in the northwest part of Prince of Wales Island.

America's Cattle Trails during the period 1540 to 1895 are traced on a map compiled by Garnet M. and Herbert O. Brayer. Hugh T. Glen is the cartographer and C. O. Froid

the illustrator. The map was copyrighted in 1949 and issued under the sponsorship of the Western Range Cattle Industry Study and the American Pioneer Trails Association of Denver, Colo. Spanish and Mexican Colonial, American Colonial, Pre-Civil War, Civil War, and Overland Trails, as well as "Trails from Texas" and "Trails from Oregon" are shown. The border of the map consists of brand marks of a number of the early cattle ranchers. Sketches of Colonel Wheeler, Charles Goodnight, Jessie Chisholm and Francisco Coronado decorate the corners.

Carte Statisque Bastide (Paris) published in 1949 two new population maps of France. *Population des Villes de France d'apres le recensement de 1946* shows population of French cities and communes of more than 1,000 inhabitants. Appropriate symbols identify 13 different setflement groups, ranging from 1,000 to 2,000 to more than 100,000 inhabitants. Fifteen inset maps show the more intensive areas of urban settlement. The scale of the map is 1:1,300,000 and it measures 34 by 33 inches. G. Peltier compiled the map and it was edited by "La Publicité Directe."

The above map has been overprinted with a color plate to show *Densité de la Population par Departements.* By a combination cross hatching and dot symbols, departments are grouped as "underpopulated," of "low density," "average density," "great density," and "overpopulated." For France as a whole the population density is given as 73.6 persons per square kilometer.

New political boundaries in the Near East are shown on the *Jewish Chronicle Map of Israel* produced under the direction of Alexander Gross and published, in 1949, by Geographers' Map Company, Ltd., of London. The map measures 34 by 19 inches and is on the scale of 1:285,120. It shows international boundaries, railways, roads, original Jewish settlements, ancient cities, U.N. partition plan boundaries, and boundaries of Israel. A comprehensive index of places borders two sides of the map. Plans of Haifa, Jaffa-Tel Aviv, Jerusalem, the Negev and the Middle East are inserted along the right margin.

Economic maps of the Saar and Ruhr areas have been published recently by the Service Cartographique, Direction de la Documentation, Secretariat General du Gouvernement (France). They were printed by l'Institut Geographique National.

The *Carte Economique de la Ruhr* is on the scale of 1:300,000 and measures 16½ by 26 inches. It shows political boundaries, the geographic and economic limits of the Ruhr, cities and towns, chemical, textile, and metallurgical industries, and foundries and factories of various types.

Carte Economique de la Sarre, at the scale of 1:100,000, measures 26 by 33 inches. In three colors, and with a number of appropriate symbols, various economic factors such as mines, forges, furnaces, smelters, industries, communications, and political boundaries are indicated.

Carte du Réseau Électrique Français et de l'Électrification des Chemins de Fer is another welcome cartographic publication of the Direction de la Documentation, Secretariat General du Gouvernement (France). It shows, by types, present and projected electric rail lines, power lines, and power stations. The map, which carries no scale, measures 29 by 28 inches.

Karte der Deutschen Länder is a map of Germany, on the scale of 1:1,000,000, recently published by Richard Schwarz of Frankfurt am Main. It measures 35 by 32 inches. Political boundaries, railroads, and occupation zones are shown. The Ruhr region is enlarged on an inset map. Provinces are shown in contrasting colors on one edition of the map, while on another, postal zones are so identified.

Swedish history is graphically portrayed on a new map entitled *Om Sverige och Svenskarnas insats i Nordens Historia Genom Tiderna.* It was prepared by Bror Hallberg and published in 1948 by Generalstabens Litografiska Anstalt of Stockholm. On the scale of 1:1,000,000, the map consists of two sheets each 36 by 52 inches. Three inset maps portray Swedish campaigns in central Europe. Coats of arms and neatly executed sketches decorate the face of the map.

Economic resources and communication lines are shown on a new map of Belgian Congo (*Congo Belge, Principales productions minérales, végétales et animales voies de communication*). It was prepared in 1947–48 by M. Norbert Laude, Directeur de l'Universite-Coloniale de Belgique. The scale is 1:2,000,000. The map is printed on two sheets each measuring 23 by 42 inches.

Carta da Colónia de Mocambique is the title of a map of Mozambique on the scale of 1:2,000,000 recently received. It was published in 1944 by the Ministerió das Colónias, Junta das Missões Geográficas e de Investigaçoes Coloniais, Lisboa, Portugal. In addition to administrative boundaries, it shows roads, railroads (operating and projected), and populated centers. The map measures 38 by 27 inches.

When the North Korean forces crossed the 38th parallel last June, the eyes of the world were focused upon Korea. There developed in consequence a great demand for maps of this heretofore little-known country. Good maps were, however, hard to come by. Best available general map was the Korean sheet (No. 4) of the four-sheet road map of Japan and Korea at the scale of 1:1,000,000, prepared by the Army Map Service (U. S. Corps of Engineers). Official requests soon depleted the distribution stock of the Korean sheet. Civilian demands for the map could not be met.

To supply the needs of amateur strategists, Rand McNally and Company in late September issued a trade edition of the A.M.S. Map of Korea, using the original plates. Measuring 36 by 26 inches, the map shows generalized relief features by means of brown shading. Roads, railroads, geographical features, and numerous cities and towns are clearly shown. The legend includes a glossary giving English equivalents for Korean generic names. The Rand McNally edition includes also a list of the principal cities, with populations and the area and population of the country. The 38th parallel is emphasized in red on the trade edition of the map.

On the verso of the *Official War Map of Korea* there are seven smaller maps showing vital Far Eastern areas. They are reproductions of plates in Rand McNally's recently issued *Cosmopolitan World Atlas.*

The cooperation between Army Map Service and Rand McNally and Company in making the map of Korea available to the non-governmental map user suggests the possibility that other similar maps might be issued in trade editions.

—Walter W. Ristow

CAPSULE ADVICE TO THE YOUNG ENGINEER

1. Guard the privileges of freedom at all times.
2. Take pride in yourself and your profession.
3. Be loyal to your employers and associates.
4. Try to develop vision as well as technical ability.
5. Study people and learn to work with them.
6. Watch three things—your health, your appearance, and your tongue.
7. Never stop studying and learning.

—*Civil Engineering,* July 1950.

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession. —EDITOR.

Topographic Maps

THE FOLLOWING topographic maps were published between July 1 and November 30, 1950 by the U. S. Geological Survey. (New Publications Lists 504 through 508.) The maps are available with or without the green overprint which indicates woodland. The quadrangle name is shown in capital letters and the county name in upper- and lower-case letters. Since many quadrangle maps extend into several counties, only that county name is given which contains the place or feature for which the quadrangle is named. For example, the quadrangle ARAB, in *Alabama*, is in parts of Marshall, Cullman, and Blount counties, but only Marshall is shown because the town of Arab is in that county.

Maps of areas east of the Mississippi River may be ordered from the Chief of Distribution, U. S. Geological Survey, Washington 25, D. C., and of areas west of the Mississippi River from the Distribution Section, U. S. Geological Survey, Denver Federal Center, Denver, Colo.

Alabama

ALBERTVILLE
Marshall†

ARAB
Marshall

CAIRO
Lauderdale

CENTER GROVE
Morgan†

DUTTON
Dutton

ENTERPRISE*
Coffee

FARLEY
Madison

GRANT
Marshall

GUNTERSVILLE
Marshall

GUNTERSVILLE DAM
Marshall

HUNTSVILLE
Madison†

JONES CROSSROADS
Limestone

LANGSTON
Jackson†

LIM ROCK
Jackson†

MADISON
Madison†

MT. CARMEL
Marshall†

NAUVOO
Walker

NEW HOPE
Madison

NEWSOME SINKS
Morgan

OZARK*
Dale

PAINT ROCK
Jackson

SCOTTSBORO
Jackson†

STEVENSON
Jackson†

SWEARINGEN
Marshall

SYLVANIA
DeKalb

TRINITY
Morgan

Alabama-Tennessee

DORAN COVE
Jackson†

Alaska

JUNEAU & VICINITY
First Judicial Division

Arizona

BRANDENBURG MT.
Pinal†

HOLY JOE PEAK
Pinal†

LOOKOUT MT.
Pinal†

SENTINEL*
Maricopa†

* Indicates 15-minute quadrangle; all others are 7½-minute quadrangles.
† Indicates map lies wholly within county named.
‡ Indicates availability in either a contour or a shaded-relief edition.

California
AMERICAN HOUSE
Plumas
ANAHEIM
Orange†
BOUCHER HILL
San Diego†
BURREL
Fresno
BURRIS PARK
Kings
CASCADE
Plumas
CHALLENGE
Yuba
CLIPPER MILLS
Butte
EL TORO
Orange†
FORBESTOWN
Butte
FRENCH CORRAL
Nevada
GARDEN VALLEY
El Dorado†
GEORGETOWN
El Dorado
GOOSE LAKE
Kern†
GOSHEN
Tulare
GRASS VALLEY
Nevada†
GREENWOOD
El Dorado
HAMILTON CITY
Glenn†
KIRKWOOD
Tehama
LAKE COMBIE
Nevada
LAS PLUMAS
Butte†
LOKERN
Kern†
LOS ALAMITOS
Orange
MARGARITA PEAK
San Diego†
OIL CENTER
Kern†
ORANGE COVE SOUTH
Fresno
PALA
San Diego†
PALOMAR OBSERVATORY
San Diego†
PECHANGA
Riverside
PLACERVILLE
El Dorado†
POINT MUGU
Ventura†
ROSEDALE
Kern†
ROUGH AND READY
Nevada†
SAN FRANCISCO NORTH
San Francisco
SEAL BEACH
Orange
SHINGLE SPRINGS
El Dorado†
SHIPPEE
Butte†
TOWNE OIL STATION
Fresno†
TRIUNFO PASS
Ventura
TRONA*
San Bernardino
VISALIA
Tulare†
WAUKENA
Tulare
WHEATVILLE
Fresno†
WOLF
Nevada

California-Arizona
PARKER*
Yuma

Colorado
ATKINSON CREEK
Montrose
CALAMITY MESA
Mesa†
DERBY
Adams
EGNAR
San Miguel
ENGLEWOOD
Arapahoe
FREDERICK
Wild
JOE DAVIS HILL
San Miguel
JUANITA ARCH
Mesa†
KERSEY
Wild†
LOUISVILLE
Boulder
PINE MT.
Mesa†
RED CANYON
Montrose

Connecticut
CORNWALL
Litchfield†
ELLSWORTH
Litchfield†
KENT
Litchfield
LITCHFIELD
Litchfield†
NEW PRESTON
Litchfield†
WOODBURY
Litchfield

Connecticut-New York
SHARON
Litchfield

Delaware-New Jersey
TAYLORS BRIDGE
New Castle

Florida
BARTOW
Polk†
HIALEAH
Dade†
JACKSONVILLE
Duval†
MULBERRY
Polk†
NORTH MIAMI
Dade
PONCE DE LEON
Holmes
PROSPERITY
Holmes†
RED BAY
Walton
RIOMAR
Indian River†

Florida-Alabama
MUNSON*
Santa Rosa

Georgia
AUGUSTA WEST
Richmond
AVONDALE
McDuffie
BLYTHE
Richmond
BOWDONS POND
McDuffie
DEARING
McDuffie
GOUGH
Burke†
GROVETOWN
Columbia
HARLEM
Columbia
HEPHZIBAH
Richmond†
KELLYS POND
Jefferson
KEYSVILLE
Burke
LOUISVILLE
Jefferson†
MATTHEWS
Jefferson

STORYS MILLPOND
Burke
WALESKA*
Cherokee
WAYNESBORO
Burke
WRENS
Jefferson

Idaho

BLISS
Gooding
GOODING BUTTE
Gooding†
HAGERMAN
Gooding
INDIAN BUTTE
Owyhee
NEWDALE
Madison
OREANA
Owyhee†
SHATTUCK BUTTE
Bonneville†
SODA SPRINGS*
Caribou

Illinois

SANDWICH*
DeKalb
SPRING BAY
Woodford

Illinois-Missouri

ALTON
Madison

Indiana

BECKS MILL
Washington†
DUNREITH
Henry
PALMYRA
Harrison
SALEM
Washington†

Indiana-Kentucky

LACONIA
Harrison

Kansas

ALIDA
Geary
PERRY
Jefferson
WILLIAMSTOWN
Jefferson

Kansas-Missouri

PITTSBURG
Crawford

Kentucky

BRUSHART
Greenup
CHARTERS
Lewis†

Louisiana

JONESBORO*
Jackson

Maine

BOIS BUBERT
Washington†
CHERRYFIELD
Washington
DRISKO IS.
Washington
GORHAM
Cumberland
GREAT WASS ISLAND
Washington†
PETIT MANAN
Washington

Maryland

DAMASCUS
Montgomery
WINFIELD
Carroll
WOODBINE
Carroll

Maryland-Pennsylvania

BEL AIR*
Harford

Michigan

BATTLE CREEK*
Calhoun
GALESBURG*
Kalamazoo
LEONIDAS*
St. Joseph
UNION CITY*
Branch

Minnesota

ALLEN
St. Louis†
GRACEVILLE*
Big Stone
ISAAC LAKE
St. Louis†
LAKE ELMO
Washington

Minnesota-Wisconsin

HUDSON
St. Croix

Missouri

BUCKLIN
Linn†
COLUMBIA*
Boone
COLUMBIA
Boone†
KAHOKA
Clark†
KAHOKA SE
Clark
NEW CAMBRIA W
Macon
ST. CLAIR*
Franklin
SENTINEL
Polk
SMITHVILLE
Clay

Montana

PORTAGE*‡
Cascade
TIMBER COULEE*
Chouteau

Nebraska

ARTHUR*
Arthur
BASSETT NW
Brown
CARR LAKE*
Hooker
CRESCENT LAKE*
Garden†
DUTCH CREEK
Brown
HALSEY*
Thomas
HUDDLE TABLE
Keya Paha
MEADVILLE
Keya Paha
SHIMMINS LAKE*
Hooker
SKUNK LAKE*
Sheridan
VELMA*
Arthur
WHITMAN*
Grant

Nevada

CRESCENT VALLEY*
Eureka
MT. LEWIS*
Lander†

New Hampshire

HAMPTON
Rockingham†

New Mexico

COMANCHE SPRING
Chaves†
DEXTER EAST
Chaves†
DEXTER WEST
Chaves†
LAKE LUCERO
Dona Ana
LAKE LUCERO NE
Otero†
LAKE LUCERO SE
Otero†
LAKE LUCERO SW
Dona Ana

OSCURA
Lincoln
SOUTH SPRING
Chaves†
THREE RIVERS
Otero†

New York

BUFFALO NE
Erie†
BUFFALO NW
Erie†
BUFFALO SE
Erie†
DEFERIET
Jefferson†
ORCHARD PARK
Erie†
PLUM ISLAND
Suffolk†
SMITHVILLE FLATS
Chenango
TONAWANDA EAST
Erie
TONAWANDA WEST
Erie

North Carolina

CLIFFDALE
Cumberland
FAYETTEVILLE
Cumberland†
HORSEPEN POINT
Carteret†
LOBELIA
Hoke
LONG BAY
Carteret†
MANCHESTER
Cumberland
NIAGARA
Moore
NICHOLSON CREEK
Hoke†
OVERHILLS
Harnett
POINT OF MARSH
Carteret
SANATORIUM
Hoke

North Dakota

ANTLER
Bottineau†
ANTLER NW
Bottineau
BANTRY
McHenry†
BANTRY NW
McHenry†
BARLOW
Foster
BISMARCK
Burleigh
BOWBELLS*
Ward
BRANTFORD
Eddy
BRANTFORD NW
Eddy†
CARRINGTON E
Foster†
CARRINGTON SW
Foster†
CARRINGTON W
Foster†
COLUMBUS*
Burke
CROSBY*
Divide†
DEEP
Bottineau
DEERING*
McHenry
DENBIGH
McHenry†
FLAXTON*
Burke†
GRACE CITY
Foster
KARLSRUHE NE
McHenry†
LANDA
Bottineau†
LANDA SW
Bottineau†
LANSFORD*
Bottineau
MANFRED SE
Wells†
MELVILLE
Foster
MOHALL*
Renville†
NEWBURG
Bottineau
NEWBURG SE
McHenry†
NEW ROCKFORD NE
Eddy†
NEW ROCKFORD SE
Eddy
NOONAN*
Divide†
OBERON SW
Eddy
PORTAL*
Burke†
SHEYENNE
Eddy
SHEYENNE LAKE
Sheridan†
SHEYENNE LAKE NE
Sheridan
TOKIO SW
Eddy
TOWNER
McHenry†
TOWNER NW
McHenry†
WELLSBURGH
Wells
WILLOW CITY SW
McHenry
WILTON*
McLean

Oklahoma

RUSH SPRINGS*
Grady†
WEBBERS FALLS*
Muskogee

Pennsylvania

EMPORIUM
Cameron
FREELAND
Luzerne†
KEATING SUMMIT
Potter
NESQUEHONING
Carbon
NORWICH
McKean†
RICH VALLEY
Cameron
WILKES BARRE E
Luzerne†
WILKES BARRE W
Luzerne†

Puerto Rico

CULEBRA & ADJACENT IS.
Culebra†

Rhode Island

BLOCK ISLAND
Newport†

South Carolina

HUGER
Berkeley†
VERDERY
Greenwood

Tennessee

MONTEAGLE
Grundy
MT. PLEASANT
Maury†

Tennessee-Missouri-Kentucky

REELFOOT LAKE*
Ten Lake

Texas
ATHENS*
Henderson
LEXINGTON*
Lee
MERCURY*
McCullock
MULLINS*
Mills
PALESTINE*
Anderson†
RICHLAND SPRINGS*
San Saba
TENNESSEE COLONY*
Anderson
THE KELTYS
Angelina†
ZEPHYR*
Brown

Utah
CEDAR CITY NW
Iron†
MARYSVILLE*‡
Piute†
WOODSIDE*
Emery

Vermont-New York
ORWELL
Addison

Virginia
MILLBORO*
Bath
OLD CHURCH
Hanover
RICHLANDS*
Tazewell

Washington
HOLDEN*‡
Chelan

Wyoming
ANTELOPE CREEK
Converse†
CEDAR TOP
Platte
CHALK BUTTES
Converse†
CLAUSEN RANCH
Converse†
DILTS RANCH
Converse
DOUGLAS
Converse†
GLENDO
Platte
IRVINE
Converse†
LEUENBERGER RANCH
Converse†
LOCKETT
Converse
POISON LAKE
Converse†
RAGGED TOP MT.*
Albany
SHERMAN MTS.*
Albany
SPRING CREEK
Platte†

Wyoming-Colorado
CHEYENNE*
Laramie

In addition to the standard series of quadrangle maps, reconnaissance maps at the scale of 1:250,000 are being published for both the continental United States and Alaska. Maps in this series published in the period include:

Alaska
BETHEL
Fourth Judicial Division
KODIAK (A–3)**
Third Judicial Division†
KODIAK (B–3)**
Third Judicial Division†
McGRATH
Fourth Judicial Division
MIDDLETON
Third Judicial Division†

A single-sheet map has been compiled at the scale of 1:125,000 from several quadrangle maps covering the following area, with culture revision in 1949.

Tennessee–North Carolina
GREAT SMOKY MOUNTAINS NATIONAL PARK AND VICINITY‡

** These maps are published at scales of 1:63,360.

❦ ❦ ❦

Manual No. 15, Map Division, Library of Congress

THE ORGANIZATION, functions, and activities of the Maps Division are outlined in this manual. Its purpose is to explain the basic policies and operations in acquiring maps and atlases, in preparing such material for the collections, and in providing geographic and cartographic reference service. No attempt is made to describe procedures in detail; the emphasis is primarily on activities. The manual, also, attempts to fit the Division into the framework of the Library of Congress, and to show how its activities are related to those of other Divisions, and how they contribute to the general program of the Library.

The manual may be obtained from the Card Division, The Library of Congress, Washington 25, D. C., at $0.30 per copy.

Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the Congress. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR

FROM PROSPECTIVE MEMBERS

I regret that I did not know sooner of the existence of your society and its Journal. I have long felt the need of some book or periodical devoted to surveying, and particularly land surveying. The small-town civil engineering firm usually finds that 90 percent of its business is surveying, yet surveying seems to be a most neglected and looked-down-on branch of the profession. The ASCE seems to give little attention to surveying, and I cannot recall more than two or three articles in its magazine devoted to land surveying. It is no doubt interesting to read about million-dollar dams and thousand-foot bridge spans, but there are a lot of engineers who never get such design jobs and still make a good living on survey work. We can use information on how to do our type of work better.

As your magazine mentions, there is too much apology on the part of surveyors and a tendency to feel we are the poor relations of the engineering profession. This even becomes official. The California State Board of Registration for Civil and Professional Engineers does not consider surveying a branch of engineering, although until recently civil engineers and surveyors were their only two groups of clients. Still, if one passes the civil engineering examination, in which there is seldom a question on surveying and never one on legal descriptions or property laws, one can then perform any service a licensed surveyor can do in California.—GEORGE C. BESTOR, consulting engineer, Carmel, Calif., in a letter to S. A. Bauer.

Reply by S. A. Bauer

. . . We in Ohio have a situation similar to that about which you complain. The qualifications for examination as a surveyor in Ohio are identical with those of a civil engineer, as to education and length of experience, except for the fact that the engineer's experience must be in *engineering*, whereas the surveyor's experience must be in *engineering and surveying*. Upon passing the examination, the civil engineer may practice surveying without being registered as a surveyor, but the surveyor cannot practice engineering without being registered as an engineer. It is clearly an unfair and illogical situation. This is one of the problems to which the American Congress on Surveying and Mapping is dedicated.

Comment by W. C. Wattles

The reasons behind the lack of recognition are: First, the apathy and reluctance of the surveyors themselves, as a class, to assert their independence, ability, or worth, both in dollars and works; second, the training, or lack of it, given in schools and colleges, which usually stops with the bare mechanical procedure of instrument use and elementary calculation; third, the glorification of the

"civil engineer" with "surveyor" tacked on as a minor qualification; fourth, the pressure on legislation by civil engineering groups to prevent the loss, to them, of cherished rights of operation, whether or not they are qualified to exercise them.

The American Congress on Surveying and Mapping can do much to relieve the situation through membership education, and assistance to groups in furthering satisfactory legislation.

Efforts to alter the California Civil Engineer Registration law to permit practice as a land surveyor *only* after qualifying as such have so far been unsuccessful.

I am attached to the Public Works Department, Kingston, Jamaica, as a student surveyor and it is my ambition to avail myself, as far as my position will allow, of all opportunities offered for learning the profession of surveying.

I have accidentally received a copy of the January–March 1949 Journal of the Congress and on reading it I became fully captivated by its importance and am anxious to be numbered with those who receive this quarterly journal. I am therefore respectfully asking that you inform me regarding the conditions under which I may become the recipient of the Journal.—ROOSEVELT C. THOMPSON.

* * *

Third Annual Surveying and Mapping Conference

THE THIRD ANNUAL Surveying and Mapping Conference sponsored by the Civil Engineering department of the University of Florida was held on the University campus November 15 and 16. The attendance this year totaled 290.

The principal topics on the program were: Surveying and Mapping for Jim Woodruff Dam and the Central and South Florida Flood Control Project, Surveying and Mapping Activities of the County Engineers in Florida, and Problems in Land Surveying.

"Problems in Land Surveying" was presented as a discussion by a panel composed of two land surveyors, one realtor, and one title consultant.

At the dinner meeting on Wednesday evening Prof. George H. Harding of Ohio State University, first executive secretary of the American Congress on Surveying and Mapping, gave an outstanding talk on "Surveying and Mapping Education and Research in Relation to the Professional Status of Surveyors and Mappers."

On the afternoon of November 16, some 45 land surveyors met under the chairmanship of E. R. Lampp, consulting engineer, Ocala, Fla., and formed a statewide organization of land surveyors as a Surveying and Mapping Section of the Florida Engineering Society.

—T. L. BRANSFORD

CONGRESS NEWS

Officers Named for 1951

As president of the American Congress on Surveying and Mapping I am happy to announce that, in accordance with our constitution, the Board of Direction has approved the appointment of the following officers to serve for the calendar year 1951. It is both gratifying and heartening to know that they have accepted service in the Congress for another year.

Walter S. Dix, *Executive Secretary*
Richard T. Evans, *Treasurer*
Aaron L. Shalowitz, *Editor-in-Chief*

These officers have served the Congress year in and year out without compensation and in a somewhat anonymous capacity. It is therefore my pleasure to include in this issue of our Journal something of their background and professional attainments.

GERALD FITZGERALD
President

WALTER S. DIX

This marks the fifth year of Mr. Dix's service to the American Congress on Surveying and Mapping as Executive Secretary. A civil engineer with the Tennessee Valley Authority, Mr. Dix is the Washington representative and liaison officer for TVA's Maps and Surveys Branch.

Educated in engineering drafting and machine design at British and American public schools, he later received training in engineering through correspondence and university extension courses.

From 1924 to 1932 he was a member of R. H. Randall & Co., Inc., geodetic and topographic engineers with activities in some 22 cities, and The Randall Press Inc., a map engraving and publishing company. Prior to joining TVA in 1935, he served as Engineer of Field Surveys for USCWA and FERA in Lucas County, Ohio, and for the City of Toledo.

In addition to his engineering and surveying experience, he has a rich background in the graphic arts and has specialized in lithographic and photoengraving work and in map reproduction, processes, and equipment.

Mr. Dix is a registered professional engineer and surveyor from Ohio and is a charter member of the Toledo Section of Professional Engineers. He is also a charter member of the American Congress on Surveying and Mapping and has served actively on the Publications, Membership, Annual Meeting, and Constitution Committees. Other professional affiliations include the American Society of Photogrammetry and the American Society of Civil Engineers.

RICHARD T. EVANS

Richard T. Evans is a topographic engineer in the U. S. Geological Survey. He has served as treasurer of the American Congress on Surveying and Mapping since 1943, and between 1943 and 1946 he filled the offices of secretary and treasurer. A native of Washington, D. C., he received his surveying education in that city.

Major Evans' entire professional service has been with the Geological Survey to which he was appointed in 1899. His first field assignment was with a planetable topographic mapping party at Rapid City, S. Dak. Other assignments included mapping of the Shinumo and Havasu quadrangles of the Grand Canyon region, Pikes Peak and Colorado Springs, and various National parks. Among his accomplishments are the original mapping of many wilderness areas in the western part of the United States. He also served as Acting Superintendent of Zion National Park and Superintendent of Hawaii National Park. He pioneered in the use of stereophotogrammetric methods in the topographic mapping of Zion National Park and Bryce Canyon, Utah. In 1942, Major Evans was assigned to the Washington Office of the Geological Survey, where he has held positions in the editorial section and in the office of the Chief Topographic Engineer.

During World War I, he served as lieutenant with the 29th Engineers in France and was later commissioned a major in the Reserves. He is a member of the Cosmos Club, the Explorers Club, the American Society of Civil Engineers, the American Society of Military Engineers, and the American Society of Photogrammetry.

AARON L. SHALOWITZ

Aaron L. Shalowitz is an assistant to the Director of the Coast and Geodetic Survey and is chief of the Research, Review, and Technical Information Section under the Office of the Director. This will mark the ninth consecutive year of publication of SURVEYING AND MAPPING under his editorship.

A graduate of Baltimore Polytechnic Institute, Mr. Shalowitz also holds a Bachelor of Laws degree from Georgetown University and a Master of Laws from George Washington University.

His service in the Coast and Geodetic Survey began in 1916 as a commissioned officer in the field force and includes hydrographic, topographic, and geodetic surveys along the coasts of the United States, Alaska, and the Virgin Islands. Since 1921, he has been attached to the Washington Office of the Survey, where he has served in various technical and administrative capacities.

Mr. Shalowitz has specialized in the interpretation of surveys and charts for legal and technical purposes and serves as liaison officer for the Coast Survey with the Department of Justice. He is the author of numerous technical articles, papers, and reports dealing with hydrographic surveying, geographic datums, coastal changes, navigability, nautical charts, and related subjects. He collaborated in the preparation of the most recent edition of the *Hydrographic Manual* of the Coast and Geodetic Survey, and is also editor of the Bureau's technical Journal.

He is a member of the Washington Society of Engineers, the American Geophysical Union, the American Association for the Advancement of Science, and the Washington Academy of Sciences.

Résumé—Topography Division Proceedings

(Annual Meeting, June 23, 1950)

THE FIRST meeting of the reactivated Technical Division on Topographic Surveying and Mapping was held on June 23, 1950, with Chairman-elect C. S. Maltby presiding. A résumé of the reactivation, organization, and election of officers for the coming year was given.

An amendment to the constitution of the Division was presented by S. V. Griffith and adopted by unanimous vote, subject to approval of the Board of Direction of the Congress. The amendment revises Article III, Sections 2 and 7, to read:

Section 2.—"The chairman of the Division shall be elected by the members of the Division for a term of 1 year. Election shall be by letter-ballot prior to the annual meeting of the Congress."

Section 7.—"A nominating committee of three, appointed by the Board of Direction (of the Division), shall prepare a ballot to be mailed to the membership at large of the Division 60 days before the annual meeting. The ballot shall contain the names of one nominee for chairman and three nominees from government and three from non-government affiliations for directors. The nominee for director in each group receiving the largest number of votes shall be elected."

The Division unanimously approved a motion that the Board of Direction be requested to change the name of the Division from *Technical Division on Topographic Surveying and Mapping* to *Technical Division on Topography.* (Change approved by Board of Direction on November 16, 1950.)

The Division discussed suggestions for publishing in the Journal a list of new maps available. It was noted that the bimonthly *Military Engineer* contains such a list and that readers of the Journal have equal, if not greater, interest in such information. The Division approved the idea. The chairman of the Division will submit quarterly to the editor a typed list of new topographic maps.

Louis A. Woodward suggested by letter that the Congress prepare specifications for large-scale or special-purpose maps, and specifically for those prepared at scales ranging from 1 inch equals 40 feet to 1 inch equals 2,000 feet. The latter is the smallest scale used on standard topographic maps. At present Government agencies publish comparatively few maps in this scale range, while commercial map makers do most of their mapping at large scales. Industrial, civic, and highway planning groups require large-scale maps, but no standard specifications are available. After discussion, the Division voted to have a committee appointed to study the problem and prepare suitable specifications for the consideration of the Congress.

The problem of contour accuracy specifications on standard topographic maps was discussed at length. It was referred to the committee on technical standards for study and appropriate action.

John S. McCall discussed adaptation and use of the Wild T-3 theodolite for flare triangulation over water or inaccessible terrain. A paper on this instrument and its use is planned for later publication.

After reports had been given by Division committee chairmen, the meeting was adjourned.

C. S. MALTBY,
Chairman

Annual Financial Statement

(As of December 31, 1950)

INCOME

Dues and memberships received	*1949*	*1950*	*Year ending 12/31/49*	*Year ending 21/31/50*	*Differences*
Individual	1239	1323	$6,241.75	$7,204.43	
Library	158	168	658.25	726.05	
Sustaining	13	14	325.00	350.00	
Subscriptions	4	1	19.00	4.00	
Previous year's dues	0	0	0.00	91.91	
Total	1414	1506			
Total gross regular income			$7,244.00	$8,376.39	+ $1,132.39
Deduct membership costs			*- 371.45*	*- 788.31*	
Net regular income			$6,872.55	$7,588.08	+ 715.53
Publication sales			113.97	205.18	+ 91.21
Annual meeting and other income			876.13	751.53	- *124.60*
OPERATING INCOME			$7,862.65	$8,544.79	+ $ 682.14

EXPENDITURES

Journal (all expenses)	$4,984.87	$5,432.13	+ $ 447.26
Other printing	150.45	91.20	- *59.25*
Office supplies and Secretary's and Treasurer's expenses	707.76	1,017.95	+ 310.19
Technical Divisions	18.05	158.99	+ 140.94
Other expenditures authorized by the Board of Direction	146.17	120.49	- *25.68*
TOTAL EXPENDITURES	$6,007.30	$6,820.76	+ $ 813.46
SURPLUS	+ 1,855.35	+ 1,724.03	- *131.32*

ASSETS

Bank balance	$4,879.84	$2,123.49	- *$2,756.35*
Bonds	0.00	4,055.00	+ 4,055.00
Journal (back issues—estimated)	300.00	300.00	0.00
Emblems (at cost)	77.09	20.09	- *57.00*
Advance payments	0.00	208.11	+ 208.11
Accounts receivable	76.17	9.50	- *66.67*
TOTAL ASSETS	$5,333.10	$6,716.19	+ $1,383.09

LIABILITIES

Advance dues paid	$ 594.31	$1,809.00	+ $1,214.69
Oct.–Dec. Journal	1,232.63	0.00	- *1,232.63*
Other accounts payable	331.00	8.00	- *323.00*
TOTAL LIABILITIES	$2,157.94	$1,817.00	- *$ 340.94*
NET WORTH OF CONGRESS	$3,175.16	$4,899.19	+ $1,724.03

K. T. Adams, *Chairman*
Budget and Finance

JOHN SIMPSON DODDS, 1885–1950

On November 3, 1950, one of the outstanding leaders in the surveying and mapping field passed out of this world into that special Valhalla which must be reserved for those individuals in each generation who leave their segment of the world, and their profession, just a bit better for having been a part of it. Prof. John Simpson Dodds of Iowa State College belonged to, and was part of, surveying and mapping education in the United States for thirty-odd years.

Born in Northfield, Minn., on August 10, 1885, he received his early schooling in Mankato, Minn. His surveying career began during his high school years when he worked summers with a civil engineer doing survey work. After graduation, he joined a government survey party in North Dakota. His formal education in civil engineering began in 1909 at Iowa State from which he was graduated a bachelor of science in civil engineering in 1912 and received the degree of civil engineer in 1917. From that time on he served his alma mater without interruption until his death.

Professor Dodds was secretary of the Iowa Engineering Society from 1923 to 1940 and was chairman of the Executive Committee of the Surveying and Mapping Division of the American Society of Civil Engineers during 1949. As chairman of Committee VIII, Surveying and Mapping, of the American Society for Engineering Education, he was responsible for the first conference of surveying and mapping teachers at the Iowa State College Surveying Camp at Rainy Lake, Minn.

During the early years of the American Congress on Surveying and Mapping, Professor Dodds served untiringly in developing the policies of the Congress and helped in the resolution of many organizational problems. In 1943 he served as the second president of the Congress, and it was during his administration that the publication of the Bulletin, now SURVEYING AND MAPPING, was resumed.

Professor Dodds served many other organizations concerned with surveying and mapping. His earnestness, enthusiasm, and determined effort to improve the quality of surveying and mapping instruction and the professional status of the surveyor and mapper will live on through the determination engendered in those with whom he came in contact. His friendly sincerity made many friends and did much to advance the cause in which he was so interested. He was highly respected and admired by those who knew him. Paul Bunyan, the hero of many of his countless anecdotes, had perhaps a real-life prototype in this friendly son of Minnesota.

To those of us who knew him well, he is still here, as evidenced by the success of ideas which he strove for many years to establish. So long as surveying and mapping progresses, just so long will Jack Dodds live on in the hearts and minds of those who knew him. He had long planned for a reunion, at the same campsite, of those men who composed the Rainy Lake meeting. It has not been held yet, but it would not be surprising if somewhere Jack has found Todd of Purdue and Dibert of W. and L. E. Gurley, and they have formed a committee to welcome the rest of the group when they arrive.

The American Congress on Surveying and Mapping salutes Professor Dodds for what he was, and for what he did, and hopes the spark that he kindled in other hearts and minds will continue to burn brightly for many years to come.

— GEORGE H. HARDING

NEW MEMBERS

INDIVIDUAL MEMBERSHIPS

ADAMS, DAVID HUGH, Shell Oil Co., Box 2099, Houston, Tex.

ADAMSKY, ANNA ANIELA, (Mrs.), 332 S. Patterson Park Ave., Baltimore 31, Md.

AGGELER, C. J., City College of San Francisco, San Francisco 12, Calif.

AKKERMAN, W. H., Engineer, Brazos Oil and Gas Co., 1401 City National Bank Bldg., Houston 2, Tex.

ANDRAGG, JOHN N., Surveyor and Engineer, Box 215, Auburn, Calif.

ANGAS, ROBERT M., 420 Hildebrandt Bldg., Jacksonville, Fla.

ANGERMEIER, ROBERT, Surveyor, 32 W. Park St., Stockton 16, Calif.

BAGROWSKI, BENEDICT P., 59 Green Acres, Rolla, Mo.

BAILEY, DONALD G., 203 Summer St., Ojai, Calif.

BARRITT, CLIFFORD L., Surveyor, USGS, Box 133, Rolla, Mo.

BARTHOLD, ED., USGS, 1109 N. Highland St., Arlington, Va.

BARTOL, ROBERT G., 1609 Cedar St., Rolla, Mo.

BATSON, WILBUR C., USGS, Box 133, Rolla, Mo.

BEDESEN, W. E., Engineer and Surveyor, P.O. Box 391, Merced, Calif.

BEINHAUER, WILLIAM, Surveyor, P. O. Box 725, Isleton, Calif.

BEITLE, RALPH L., USGS, 1109 N. Highland St., Arlington, Va.

BENNETT, JOHN F., Engineer, Gulf Oil Corp., 1324 Gulf Bldg., P. O. Box 2100, Houston, Tex.

BERG, T. M., 656 N. Randell Rd., Aurora, Ill.

BERRY, DICK, L. L. Ridgway Co., 615 Caroline St., Houston, Tex.

BERRY, JAMES T., 1019 Lynwood Dr., Rolla, Mo.

BESTOR, GEORGE C., P. O. Box LL, Carmel, Calif.

BLANKENBAKER, FISHER F., USGS, 1109 N. Highland St., Arlington, Va.

BLIZZARD, DOUGLAS G., USGS, P. O. Box 346, Sacramento 2, Calif.

BLUCHER, CONRAD M., Engineer and Surveyor, 245 Rosebud, Corpus Christi, Tex.

BOECKMAN, GEORGE O., M.S.M., Apt. R–2, Rolla, Mo.

BOEKENKAMP, ROBERT L., USGS, Box 133, Rolla, Mo.

BOND, FRANK, Surveyor, Rt. 3, Box 412, Petaluma, Calif.

BOOTH, ALFRED W., Dr., Dept. of Geography, Univ. of Illinois, Urbana, Ill.

BOWER, WILLIAM M., Surveyor, 816 W. 56th St., Los Angeles 37, Calif.

BOYLES, J. STUART, Engineer and Surveyor, 601 Stewart Bldg., Houston 2, Tex.

BRADY, STANLEY B., 1615 Spencer St., P. O. Box 508, Rolla, Mo.

BREVER, MARVIN H., 1606 Pine St., Rolla, Mo.

BRIZARD, ALEX., Surveyor, 738 5th St., Eureka, Calif.

BROSHOT, ARTHUR E., USGS, Box 133, Rolla, Mo.

BROWN, WARREN R., USGS, P. O. Box 346, Sacramento 2, Calif.

BRUNO, EVERETT W., USGS, Box 133, Rolla, Mo.

BUCK, WILLIAM N., USGS, Box 346, Sacramento 2, Calif.

BULLIS, M. O., Surveyor, Commonwealth Edison, Rm. 825, 72 W. Adams St., Chicago, Ill.

BULTON, EUGENE D., Surveyor, 307½ California Ave., Modesto, Calif.

BUTLER, JOE, Engineer, Florida State Road Dept., P. O. Box 1499, Fort Lauderdale, Fla.

CAMERON, THEODORE F., USGS, Box 346, Sacramento 2, Calif.

CAMP, RUFUS S., Surveyor, 604 S. Capitol St., Salinas, Calif.

CAMPBELL, WILLIAM R., USGS, Box 346, Sacramento 2, Calif.

CANFIELD, JAMES B., USGS, Box 133, Rolla, Mo.

CAREY, ROY E., USGS, Box 133, Rolla, Mo.

CARTER, R. V., Engineer and Surveyor, 702 Hamilton St., Williamsburg, Va.

CHAN, HARRY CHARLES, USGS, Box 346, Sacramento 2, Calif.

CHRISTENSON, JAMES A., Engineer and Surveyor, 373 Central St., Mansfield, Mass.

CHURCH, JACK P., USGS, Box 346, Sacramento 2, Calif.

CHUTE, GORDON L., USGS, 1109 N. Highland St., Arlington, Va.

CISSNA, VOLNEY J., JR., 1105 Lynwood Dr., Rolla, Mo.

CLAUSEN, ELMER L., Clausen and Co., 228 N. LaSalle St., Chicago 1, Ill.

COOPE, ALBERT, P. E., Court House, Market St., Youngstown, Ohio

COOPER, DANIEL C., P. E., 246 Charles St., Watertown, N. Y.

COOPER, WALLACE A., Surveyor, 1211 16th St., Sacramento, Calif.

CROSSER, ROBERT E., Surveyor, Civil Courts Bldg., Houston, Tex.

CROWELL, H. G., USGS, Box 133, Rolla, Mo.

DALEY, R. K., L.L.B. and L.S., Title Survey Div., Stanolind Oil and Gas Co., P. O. Box 3092, Houston 1, Tex.

DARBY, HAROLD A., Surveyor, 35 S. Raymond Ave., Pasadena, Calif.

DAVIDSON, JOHN I., 9017 Lindale Dr., Bethesda 14, Md.

DAVIS, JESSE Z., USGS, Box 346, Sacramento 2, Calif.

DePRIM, NICK S., Surveyor, 21 S. Hine St., Youngstown, Ohio

DOGAN-YURUK, TECIM EVI, Ragip Erensoy, Sogut Str. Latif Han No 3–5, Istanbul-Galata, Turkey

DORNIER, FELIX L., JR., Shell Oil Co., Land Dept., Houston, Tex.

DUTRA, WILLIAM EDWARD, Surveyor, P. O. Box 1124, Newark, Calif.

DUVALL, JOSEPH W., 208 Olive St., Rolla, Mo.

ECKLUND, C. A., USGS, Box 346, Sacramento 2, Calif.

EISENHARDT, WILLIAM C., USGS, Box 346, Sacramento 2, Calif.

ELLIOTT, CHARLES W., Surveyor, 1558 Medlock Rd., Decatur, Ga.

ERICKSON, PHILIP C., USGS, Box 346, Sacramento 2, Calif.

EVANS, JOHN A., USGS, Box 133, Rolla, Mo.

FARMER, JOHN L., USGS, Box 346, Sacramento 2, Calif.

FARMER, SAM D., USGS, Box 133, Rolla, Mo.

FARRINGTON, EVAN G., USGS, Box 346, Sacramento 2, Calif.

FERGUSON, ROY FRANCIS, P. O. Box 506, Rolla, Mo.

FIEBELMAN, JACOB P., Box 605, Rolla, Mo.

FINCH, JOHN D., USGS, Box 133, Rolla, Mo.

FISHER, DAVID, C. E., Bureau of Reclamation, P. O. Box 307, Elverta, Calif.

FOLLOWILL, RICHARD J., 1900-B N. Walnut, Rolla, Mo.

FONG, TOON Y., USGS, Box 346, Sacramento 2, Calif.

FRAENZA, WILLIAM A., USGS, Box 346, Sacramento 2, Calif.

FRENCH, JAMES H., USGS, Box 133, Rolla, Mo.

GANN, IRVING T., SR., Surveyor, 6615 Cleon Ave., N. Hollywood, Calif.

GARDNER, HOMER M., Engineer, County Highway Supt., Austin, Ind.

GARMANY, H. M., Engineer and Surveyor, P. O. Box 1831, Savannah, Ga.

GATZERT, CLIFFORD, Surveyor, P. O. Box 24, Lodi, Calif.

GEHRES, WILMER S., 1804 N. Elm St., Rolla, Mo.

GERLACH, ARCH C., Dr., Chief, Map Division, Library of Congress, Washington, D. C.

GILLESPIE, BERKELEY S., Engineer, Wise Engineering Co., Big Stone Gap, Va.

GOLDMAN, MARTIN, Surveyor, Mahoning County Court House, Youngstown, Ohio

GOMOLKA, EUGENE G., USGS, 1109 N. Highland St., Arlington, Va.

GOSEN, JOHN W., USGS, Box 133, Rolla, Mo.

GOUCHENOUR, EDWARD W., USGS, Box 133, Rolla, Mo.

GOULD, SAMUEL, JR., Engineer, Court House, Youngstown, Ohio

GRANT, U. S., Engineer, 831 State St., Santa Barbara, Calif.

GRAPES, HOWARD E., Sgt., RA–37495165, Dept. of Observation, TAS, Fort Sill, Okla.

GREENUP, WILBUR E., USGS, Box 346, Sacramento 2, Calif.

GRIMM, KENNETH B., JR., Surveyor, 713 Jefferson St., Fairfield, Calif.

GRIMM, LLOYD E., USGS, Box 133, Rolla, Mo.

GROW, GEORGE S., Surveyor, c/o Engineering and Development Assoc., 1915 Peachtree Rd., N. W., Atlanta, Ga.

HAMKE, ROBERT F., USGS, 1109 N. Highland St., Arlington, Va.

HAMPTON, AMBROSE G., Engineer, P. O. Box 1857, Raleigh, N. C.

HANNA, WALTER J., JR., Surveyor, 314 First St., Gilroy, Calif.

HARDEN, MILTON J., USGS, Box 133, Rolla, Mo.

HARDING, CHARLES E., USGS, Box 133, Rolla, Mo.

HART, DAVID L., USGS, Box 133, Rolla, Mo.

HENDRICKSON, MILTON C., U. S. Bureau of Reclamation, P. O. Box 307, Elverta, Calif.

HILLMAN, E. A., Surveyor, Signal Oil and Gas Co., 2501 E. Willow, Long Beach 6, Calif.

HOEFT, FRANKLIN R., Rt. 2, Box 52, Princeton, Minn.

HOGAN, EARL M., USGS, P. O. Box 346, Sacramento 2, Calif.

HOLLOWAY, CEDRIC F., 802 E. 6th St., Rolla, Mo.

HOSOKAWA, KENJI, USGS, P. O. Box 346, Sacramento 2, Calif.

HUGHES, JOE W., Shell Oil Co., P. O. Box 2099, Houston, Tex.

HUGHES, ROBERT H., Engineer and Surveyor, 752 Mineral Spring Rd., Youngstown 11, Ohio

HUGHES, THOMAS A., USGS, Box 133, Rolla, Mo.

JACKSON, A. L., 400 Oil and Gas Bldg., Houston, Tex.

JACKSON, EMORY A., 1002 Cedar St., Rolla, Mo.

JEFFS, DONALD R., 2124 Bell St., Sacramento 15, Calif.

JOHNSON, LEWIS L., USGS, Box 133, Rolla, Mo.

JORDAN, JOHN, Rt. 1, Box 170, Rio Linda, Calif.

JORDAN, RUSSELL A., JR., Engineer, Apt. #4, 3515 Purdue, Houston, Tex.

JOSEPH, MARVIN M., Engineer and Surveyor, 472 N. Liberty St., Elgin, Ill.

KABLESH, HARRY, USGS, Box 133, Rolla, Mo.

KAUFMANN, GEORGE A., USGS, P. O. Box 346, Sacramento 2, Calif.

KEERL, WIN I., Surveyor, 691 Coast Blvd. S., Laguna Beach, Calif.

KELLER, B. R., Tennessee Gas Transmission, Commerce Bldg., Houston, Tex.

KENNEDY, WILLIAM V., USGS, Box 133, Rolla, Mo.

KNIPHORST, BOEKHANDEL, Hoogstraat 49, Wageningen, Holland

LARKINS, MALCOLM G., JR., USGS, Box 346, Sacramento 2, Calif.

LARSON, LESTER A., C. E., 1384 S., 14th East, Salt Lake City, Utah

LAVERY, FREDERICK G., 1805 Cedar St., Rolla, Mo.

LEE, DOUGLAS R., Rt. 3, Box 101, Picayune, Miss.

LINDENFELD, JOHN A., Surveyor, Los Angeles Transit Lines, 717 E. 16th St., Los Angeles, Calif.

LINDSTROM, JOHN M., Engineer, 317 S. West Ave., Elmhurst, Ill.

LIVINGSTON, GEO. M., Engineer, The Texas Co., 1610 National Standard Bldg., Houston, Tex.

LOCKTON, EUGENE, Engineer and Surveyor, 20 Hillcrest Dr., San Rafael, Calif.

LOGAN, WILLIAM F., USGS, P. O. Box 133, Rolla, Mo.

LONG, J. T., USGS, P. O. Box 346, Sacramento 2, Calif.

LYMAN, EARL W., Surveyor, 597 Church St., Bloomington, Calif.

McCONNELL, HUNTER J., USGS, Topographic Br., P. O. Box 346, Sacramento 2, Calif.

McGREGOR, JOHN W., 1101 Lynwood Dr., Rolla, Mo.

McGUIRE, C. T., Surveyor, Raddue Bldg., Grass Valley, Calif.

MacKAY, HAROLD L., USGS, P. O. Box 346, Sacramento 2, Calif.

McLAUGHLIN, J. W., Engineer and Surveyor, 400 N. E. 3rd Ave., Fort Lauderdale, Fla.

McLERRAN, JAMES HERSCHEL, 635 Ferry St., Lafayette, Ind.

MANSFIELD, LLOYD B., USGS, P. O. Box 346, Sacramento 2, Calif.

MARKUSSEN, KENWOOD M., 810 Orchard St., Rolla, Mo.

MASON, BERTELL, JR., Box 292, Oak Grove, Oreg.

MILARDOVICH, JOSEPH A., USGS, P. O. Box 346, Sacramento, Calif.

MILLER, BILL, Stramler and Miller, 403 Milam Bldg., Houston, Tex.

MILLER, CHARLES C., C. E., 1200 S. Stoneman Ave., Alhambra, Calif.

MILLER, W. H., Director, Surveys and Mapping Br., Dept. Mines and Tech. Surveys, Ottawa, Canada

MILLS, NEAL, 738 Maltman Ave., Los Angeles 26, Calif.

MILLS, R. EWELL, Engineer, The Texas Co., P. O. Box 2332, Houston 1, Tex.

MILSTED, HARRY S., USGS, P. O. Box 133, Rolla, Mo.

MITCHELL, SAM E., 301 W. 6th St., Casseville, Mo.

MOORHEAD, J. R., C. E., Moorhead Engineering Co., P. O. Box 495, Ocala, Fla.

MURAKAMI, SHOZO T., USGS, P. O. Box 346, Sacramento 2, Calif.

MURPHY, THORIST F., USGS, P. O. Box 346, Sacramento 2, Calif.

MURPHY, WILBURN D., USGS, Box 346, Sacramento 2, Calif.

MURRAY, LAURENCE W., Engineer and Surveyor, 411 2nd Ave., N. E., Belmond, Iowa

NELSON, ELBERT L., USGS, P. O. Box 346, Sacramento 2, Calif.

NELSON, TOIVO J., USGS. P. O. Box 346, Sacramento 2, Calif.

NIFONG, FORREST, Engineer, Standard Oil Co., Wood River, Ill.

NOLTE, GEORGE S., Engineer and Surveyor, 310 University Ave., Palo Alto, Calif.

NORDEN, HARRY S., Engineer and Surveyor, 53 N. Jackson St., Mobile, Ala.

OBERG, S. W., Engineer, Humble Oil and Refining Co., 1216 Main St., Houston 1, Tex.

O'CONNOR, T. L., Surveyor, P. O. Box 252, Lower Lake, Calif.

O'DEA, JAMES C., USGS, P. O. Box 346, Sacramento 2, Calif.

O'HARA, JOHN L., R. F. D. 1, Box 515, Sonora, Calif.

PARKER, CLYDE H., USGS, Box 133, Rolla, Mo.

PARKER, HERMAN, Surveyor, Ludowici, Ga.

PARR, CLYDE L., Surveyor, 1125 Brown St., Bakersfield, Calif.

PARTLOW, ROSS G., JR., Engineer, 1906 Jefferson Dr., Liberty, Tex.

PATHE, CARL, Engineer and Surveyor, 4310 N. Keystone Ave., Chicago 41, Ill.

PERLENFEIN ARTHUR, 2236 Ralston Rd., Sacramento 15, Calif.

PETERSON, L. K., USGS, P. O. Box 346, Sacramento 2, Calif.

PINKERTON, DANIEL L., USGS, Box 346, Sacramento 2, Calif.

PLATT, WAYNE K., USGS, Box 346, Sacramento 2, Calif.

PLOETZ, ALFRED L., USGS, P. O. Box 346, Sacramento, Calif.

PONTON, SAMUEL, Surveyor, Rt. 3, Box 241, Vista, Calif.

POWELL, GILBERT S., Surveyor, Rt. 1, Box 1477, La Mesa, Calif.

POWERS, A. THOMAS, 1744 Wymore Ave., E. Cleveland, Ohio

PRICE, FREDERICK SOMERS, Engineer and Surveyor, P. O. Box 1174, Wilmington, Del.

PYLE, ALBERT L., Surveyor, U. S. Soil Conservation Service, Albion, Ind.

RANDALL, FRED R., USGS, Box 346, Sacramento 2, Calif.

RICHARDS, EUGENE W., Ensign, Rt. 1, Box 118, Woodinville, Wash.

ROBERTS, RALPH G., USGS, Box 133, Rolla, Mo.

ROBINSON, RAYMOND W., Surveyor and Engineer, 210 E. 153rd St., Harvey, Ill.

ROSS, CHARLES F., 14521 Evanston, Detroit 24, Mich.

ROTHER, JOHN F., Engineer and Surveyor, 2109 Ave. "G", Bay City, Matagorda, Tex.

ROTHER, WALTER M., USGS, Box 133, Rolla, Mo.

ROY, C. WAYNE, 300 E. 5th St., Rolla, Mo.

SANDERS, BERNARD, USGS, Box 133, Rolla, Mo.

SARGENT, LOREN J., Surveyor, 2046 Canal Dr., Redding, Calif.

SARTAIN, RAYMOND R., Engineer, Gulf Oil Corp., P. O. Box 2100, Houston 1, Tex.

SAVAGE, FRANK D., Engineer, Gulf Oil Corp., P. O. Box 2100, Houston 1, Tex.

SCHMAHL, EDWARD L., 5229 W. 20 St., Los Angeles, Calif.

SCHMITT, ALBERT C., 205 W. Wacker Dr., Chicago 6, Ill.

SCHOFIELD, CALVIN O., C. E., Wichita Valley Flood Control Project, P. O. Box 3013, Airport Branch, Wichita 13, Kans.

SCHREINER, GILBERT O., USGS, Box 133, Rolla, Mo.

SCHULTZ, JACK T., Box 555, Rolla, Mo.

SCRUGGS, MACK O., Indian Valley Light and Power Co., P. O. Box 126, Greenville, Calif.

SENECHALLE, LESTER J., Surveyor, 2240 W. 113 St., Chicago, Ill.

SHIELDS, JOHN M., USGS, Box 133, Rolla, Mo.

SITES, L. E., 1503 Holloway St., Rolla, Mo.

SMITH, CHARLES H., Surveyor, Crawfordville, Ga.

SMITH, J. T., JR., c/o Georgia Power Co., Box 1719, Atlanta 1, Ga.

SMITH, KEITH R., 4162 Broadway, Sacramento 17, Calif.

SNYDER, DAVID S., Surveyor, Downieville, Calif.

SOMERS, JAMES W. V., 1008 Pine St., Rolla, Mo.

SPARLING, ROBERT J., Bausch and Lomb Optical Co., Instrument Dept., 635 St. Paul St., Rochester, N. Y.

STEINBRECHER, HAROLD F., Engineer and Surveyor, 915 N. West St., Wheaton, Ill.

STEINMETZ, LEO E., 107 S. Rolla St., Rolla, Mo.

STEWART, RUSSELL H., USGS, P. O. Box 346, Sacramento 2, Calif.

STIREWALT, F. S., Surveyor, Box 763, Sonora, Calif.

STITES, CARMEL L., USGS, Box 133, Rolla, Mo.

STRIEKERT, H. F., Gulf Oil Corp., 1307 Gulf Bldg., P. O. Box 2100, Houston, Tex.

STRIEKERT, ROY R., Gulf Oil Corp., 1301 Gulf Bldg., P. O. Box 2100, Houston Tex.

TANNER, WILLIAM S., JR., USGS, P. O. Box 346, Sacramento 2, Calif.

TELLER, HERBERT L., JR., USGS, P. O. Box 346, Sacramento 2, Calif.

TENNANT, JAMES N., USGS, P. O. Box 346, Sacramento 2, Calif.

TEX, GEORGE N., Engineer, Hobson Star Rt., Rolla, Mo.

THOMAS, WALTER L., USGS, Box 346, Sacramento 2, Calif.

THOMPSON, MERCER V., 1508 Ozark St., Rolla, Mo.

THOMPSON, MORRIS M., USGS, 7232 GSA Bldg., Washington 25, D. C.

THORNTON, KARL, USGS, P. O. Box 346, Sacramento 2, Calif.

TIBBS, DOUGLAS D., USGS, Box 346, Sacramento 2, Calif.

TIBEY, EDWARD A., 3904 24th St., Del Paso Heights, Calif.

TOMLINSON, JAMES A., Engineer, Humble Oil and Refining Co., 1216 Main St., Houston 1, Tex.

TRACY, JAMES H., USGS, P. O. Box 346, Sacramento 2, Calif.

TREVALLEE, GUY A., USGS, P. O. Box 346, Sacramento 2, Calif.

TUNNICLIFF, ROBERT G., Surveyor, 611 Putnam Bldg., Davenport, Iowa

VAN DYKE, A. J., Engineer, Texas Highway Dept., P. O. Box 387, Jacksboro, Tex.

VERNER, PARK L., Surveyor, 460 Park Ave. San Jose, Calif.

VERRILL, GEORGE, Surveyor, 6 N. Edgewood Ave., La Grange, Ill.

VON GERLDERN, EDWARD, C. E., 430 2nd St., Yuba City, Calif.

WALLACE, ARCHIBALD SAMUEL, Engineer and Surveyor, P. O. Box 812, London, Ontario, Canada

WALLACE, DALLAS C., 1602 Cedar St., Rolla, Mo.

WARD, EARL B., Surveyor, Trans-Arabian Pipe Line Co., Box 1348, Beirut, Lebanon

WARDIN, R. W., 1009 W. 20 St., Cedar Falls, Iowa

WATKINS, JAMES L., USGS, 1109 N. Highland St., Arlington, Va.

WATSON, RICHARD E., USGS, P. O. Box 346, Sacramento 2, Calif.

WAY, ALFRED F., Surveyor, 88 Clifton Ave., Springfield 5, Mass.

WEBSTER, EDGAR E., III, Surveyor, 130 E. Liberty Dr., Wheaton, Ill.

WEHMEIER, RAY E., USGS, Box 133, Rolla, Mo.

WEISHAPPLE, CHARLES E., USGS, Box 133, Rolla, Mo.

WESTINGHOUSE, GEORGE F., USGS, 1109 N. Highland St., Arlington, Va.

WHIPP, WILTON SMITH, Engineer and Surveyor, 3214 W. Broadway, Hopewell, Va.

WICKHAM, W. W., 1015 N. Hamilton Blvd., Pomona, Calif.

WIGHT, RAULIN B., 1008 Curtiss St., Downers Grove, Ill.

WILKINSON, ERNEST C., 1400 Pine St., Rolla, Mo.

WILLIAMS, JAMES J., USGS, Box 133, Rolla, Mo.

WILLIAMS, LeROY E., USGS, Box 133, Rolla, Mo.

WILLIAMSON, ROBERT E., 42 Great Oaks St., Rolla, Mo.

WOLF, WHITNEY W., Engineer, 132 W. Kaley Ave., Orlando, Fla.

WOPAT, VICTOR H., USGS, P. O. Box 346, Sacramento 2, Calif.

YOAKUM, BENJAMIN H., 2520 Marconi Ave., Sacramento, Calif.

YOUNG, OLIVER E., Engineer, Humble Oil and Refining Co., 1216 Main St., Houston 1, Tex.

ZELENKA, ANTHONY J., Engineer and Surveyor, 2331 S. Lombard Ave., Cicero 50, Ill.

ZIEKE, GEORGE F., Engineer and Surveyor, 1508 Fulton Ct., Davenport, Iowa

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A Costly Error

A CHICAGO BUILDING CONTRACTOR recently filed suit in a Federal court against a well-known chain store and a manufacturer. In his suit he asked for damages of $20,000.00 due to the fact that a 25-foot tape sold him by the store, and made by the manufacturer, was actually 26 feet long, having two 12-foot markings. Six garages, intended to be 20 by 20 feet, turned out to be 21 by 21 feet, and a house designed with the same tape measured 1 foot in excess in both length and width.

The moral of this tragedy, to surveyors, probably is that all measuring devices should be either of a known calibration, or have their calibration determined. An error of 1 foot in 25 would certainly be considered excessive in surveying terms. In order to develop the accuracies specified by the *Technical Standards for Property Surveys* of the Congress, a 100-foot tape should have an error of not to exceed 0.005 foot, without special calibration and adjustment for absolute length.

—S. A. BAUER

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